NUCLEAR POWER AND ENERGY AGENCY (NuPEA) formerly KNEB

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STRATEGIC ENVIRONMENTAL AND SOCIAL ASSESSMENT REPORT (SESA) FOR THE KENYA'S NUCLEAR POWER PROGRAMME

FINAL DRAFT REPORT

September 2021

SGS SCK·CEN HS

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CERTIFICATION

The Working Group composed of SGS Kenya as main contractor, working with Belgian Nuclear Research Centre SCK·CEN (BNRC) and EHS as subcontractors all commissioned by the Nuclear Power Energy Agency formerly Kenya Nuclear Electricity Board to undertake Strategic Environmental and Social Assessment for the proposed Nuclear Power Programme in Kenya. This Strategic Environmental and Social Assessment Report has been compiled for submission to the National Environment Management Authority (NEMA).

The Working Group submits this SESA Draft Report, to NEMA Kenya. To the best of our knowledge, all the information in this report is true and correct.

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EXECUTIVE SUMMARY

The national electricity demand in Kenya is projected to increase significantly in the near future as the country gears towards a middle-income economy. Kenya's development footprint, Vision 2030, has identified energy as a key driver for sustainable growth. The energy sector is expected to provide adequate, affordable and reliable supply of energy to meet the development needs of the country.

The Kenya's Least Cost Power Development Plan (LCPDP 2017-2037) projects the estimated peak demand for the period 2017-2037 from 1,754MW to 6,638MW in the medium case scenario, because of the rapidly increasing use of electricity for industrial, commercial and household use. This has called for the need to enhance and diversify national power generation and supply by identifying new generation and supply sources with a resultant challenge to produce energy that is affordable, reliable, clean and sustainable. Nuclear energy provides such an option as it is the most viable for base load operation, is efficient and most importantly, reliable. It is projected that as at 2037, nuclear energy shall be contributing a total of 6.638 MW into the national grid.

The Nuclear Power and Energy Agency (NuPEA), formerly Kenya Nuclear Electricity Board (KNEB), is a State Corporation established under the Energy Act 2019. It is charged with the responsibility of promoting and implementing Kenya's Nuclear Power Programme, carrying out research and development for the energy sector. Towards attainment of its mandate, the Nuclear Power and Energy Agency shall develop policies and legislation, undertake public education and awareness, identify suitable sites for the construction of Nuclear Power Plants; carry out research, development and innovation on energy technologies as well as capacity building for the energy sector.

To fully understand the impact of the Nuclear Power Programme, NuPEA engaged accredited environmental and social experts to conduct a Strategic Environmental and Social Assessment (SESA). The purpose for the SESA as per the Request for Proposal's Terms of Reference is to assist Kenya to systematically and comprehensively address the unique issues of nuclear power programme based on the Strategic Plan for Nuclear Power Programme for Kenya and any other relevant information. The SESA outputs present a unique opportunity for the country to systematically address environmental and socio-economic management issues pertaining to Nuclear Power Programme activities in the context of sustainable development.

The SESA will assist Kenya to systematically and comprehensively address the unique environmental issues of nuclear power plant operation. This SESA is based on the Strategic Plan for a Nuclear Power Programme in Kenya and any other relevant information available. The specific objectives for the SESA are –

- To ensure sustainable use of natural resources in the implementation of the nuclear power programme
- To assess the level of environmental sustainability in the proposed Nuclear Power Programme
- To devise mechanisms to ensure enhanced protection and conservation of biodiversity, natural environment and built environment in the activities of the programme
- To ensure integration of socio-economic and environmental factors in the nuclear power programme
- To ensure public/ stakeholder participation in the decision-making process for Kenya's nuclear power programme.

SESA Methodology

The methodology employed in the SESA was derived from the SESA Terms of Reference, input from the SESA team and the National Guidelines for Strategic Environmental Assessment of 2012 and other international best practices including the IAEA Guidelines for Strategic Environmental Assessment for Nuclear Power Programmes (2018).

The general scope involved the following activities:

- Identifying key economic, social and ecological issues regarding Kenya's nuclear power programme
- Drafting a list of key environmental issues associated with Kenya's Nuclear Power Programme
- Assessing the likely impact on ecological systems resulting from constructing and operating a nuclear power plant.
- Identification of relevant stakeholders for the SESA

The SESA consultation workshops were undertaken in the following regions/ counties: Kwale, Mombasa, Kilifi, Kisumu, Siaya, Busia, Homa Bay, Migori, Turkana, Uasin Gishu, Nandi, Kericho, Bomet, Nakuru, Murang'a, Nyeri, Meru, Embu, Kitui, Garissa, Lamu, Tana River City of Nairobi. Those invited to the forums were representatives from the public sector and key ministries/ inter-ministerial lead agencies / key public institutions**,** private sector actors/ investors, universities and research institutions.

Overview of the Nuclear Power Programme

The implementation of KNPP is guided by the nineteen infrastructure issues as domesticated for newcomer countries. These issues include: 1) establishing a National Position; 2) creating a Nuclear Fuel Cycle framework; 3) selecting appropriate Reactor Technology; 4) carrying-out an Electric System Analysis; 5) determining the appropriate site-selection considerations; 6) developing an appropriate Funding & Financing strategy; 7) Ensuring effective and equitable development of industrial involvement; 8) building an appropriate Legislative and Regulatory Framework; 9) Mapping and establishing criteria for Stakeholder involvement; 10) establishing capable management; 11) developing Human Resource; 12) establishing appropriate procurement framework: 13) Nuclear Safeguards; 14) ensuring Nuclear Safety; 15) ensuring Nuclear Security; 16) providing effective Physical Protection; 17) ensuring Environmental Protection; 18) ensuring Radiation Protection; 19) providing a framework for effective Radioactive Waste Management.

A criterion hinging on *technical, economic, environmental and social* sustainability was used to identify and choose between available alternative nuclear technologies. Additionally, the *demand for water* resources for cooling makes accessibility to water resources another consideration. The technology requirements for management of *reactor fuel*, was also considered. The *nuclear safety management* is key, as nuclear is seen to require significant containment in the event of unnatural or natural risks. Managing radioactive waste at the site or on transit was therefore a key consideration. Finally, the transport system reliability for the three candidate sites (Lake Victoria, Lake Turkana Basin and the Coastal Region) was considered.

The Nuclear Regulatory Act, 2019 provides the initial framework in which the KNPP has proposed domestication of key regulatory matters. This is a comprehensive regulatory framework for the

safe, secure and peaceful utilization of nuclear energy. It establishes a nuclear regulatory commission, which regulates activities including notification, authorization, inspection, enforcement and penalties. The nuclear activities considered in the Act includes production, use, import, export of radiation sources by and for authorized persons and purposes. Activities such as transport of radioactive materials, radiation practices, siting, construction, commissioning and decommissioning of facilities and management of radioactive waste will be effectively regulated in the law.

Candidate sites

Candidate site analysis was done with consideration of a wide range of criteria including the following specific parameters: geology, seismology, tectonics, soils, vegetation, hydrology, demographics and urbanization, transport infrastructure (roads, rail, ports, airports), electric grid network, socio-economics (tourist sites, national parks/reserves), environmental assets (RAMSAR sites, wildlife areas, floodplains/wetlands) and security.
According to the Criteria document, there are two processes relating to the safety considerations for the site of a nuclear installation namely: siting and site evaluation processes. This approach was used to analyse three regions, namely the Coast region, Lake Victoria region, and Lake Turkana Basin. From twenty-nine (29) NPP potential sites in Kenya, thirteen (13) sites were identified as candidate sites after the screening process and these sites were subjected to ranking based on discretionary criteria using the Analytical Hierarchy Process (AHP) to obtain the Preferred and Alternate Candidate Site for each of the three regions. The results generated using AHP for ranking are shown in the table below:

Coast Region		
SITE	**SCORE**	**POSITION**
Site A	0.138675357	6
Site B	0.192576414	2
Site C	0.143808665	4
Site D	0.184820341	3
Site G	0.199060207	1
Site H	0.141059015	5
Lake Victoria Region		
Site 4	0.256438624	2
Site 6	0.441463377	1
Site 14	0.089189084	4
Site 15	0.212908915	3
Lake Turkana Region		
Site T-1	0.455391176	1
Site T-2	0.257090148	3
Site T-3	0.287518676	2

Sensitivity analysis was applied in the Coast region where Site G scored highest in the ranking. This can be attributed to Site G being located in the sparsely populated and aseismic Lamu basin and the fact that major geologic faults occur very far from the site.
However, considering aspects like the topography, geology and flood risk, Site G (in Lamu County) was avoided, because the cost of corrective engineering measures would increase the NPP Construction costs. Thus, Site B is the Preferred Site, followed by Site D.

Potential environmental, socio-cultural, health and safety concerns and impacts of the KNPP

Nuclear power generation uses uranium as a fuel. However, the nuclear fuel for the KNNP will be sourced from the manufacturers to eliminate any emissions that may occur during mining of uranium.

Environmental Impacts

- Radioactive Waste Management from the reactors
- Impact on Important Bird Areas (IBA)
- Impacts of Nuclear Power Plant on Water Resources
- Nuclear Power activities' potential for ground water contamination
- NPP decommissioning impacts
- Terrestrial impacts and project footprint

Socio-Economic Impacts

- Employment impacts and population migrations/ influx management
- Preservation of historical, cultural resources and heritage sites
- Gender and equity
- Human rights issues
- Local livelihood and community development
- Nuclear sector security concerns
- Weapons proliferation and terrorism
- Human resource capacity
- Infrastructural capacity
- Revenue and benefit sharing
- Nuclear power programme implementation and operational costs

Occupational Safety and Health impacts

- Health impacts of nuclear power programmes
- General Environment, Health and Safety (EHS) impacts
-
- Accidental radioactive emissions
- Encroachment of the way leave
- Safety training and education
- Community health and safety
- Security issues
- Capacity building
- Information and advisory services on Occupational Health and Safety (OSH)
- Role duplication at the institutional level
- Human resource inadequacy
- Disaster risk reduction and emergency response management plans

Key Policy Recommendations

Based on environmental, socio-economic, health and safety policy gaps identified and analysed, the following key (priority) recommendations emerged from the SESA process:

Environmental Issues

- Progress towards adoption of international legal structures
- Finalize on the development of policy on spent fuel and radioactive waste management (RWM)
- Formulation of spent fuel and radioactive waste management strategies
- Development of policy and strategy for decommissioning of nuclear and radiological facilities

- Development of national guidelines for environmental and social impact assessment for both nuclear power and radioactive facilities and guidelines for project affected persons' consultation and stakeholder participation
- Develop an environmental management and coordination regulation for nuclear sector
- Development and implementation of a public participation and consultation national manual for nuclear power sector
- Development of a community user guide for environmental and social impact assessment
- Establish nuclear sector environmental management information system
- Capacity building for relevant lead agencies and improving inter-agency coordination including streamlining environmental roles and responsibility
- Enhancing capacity for the institution of nuclear science at local universities and Technical and Vocational Education and Training (TVET) centres
- As an institutional gap, there is need to establish a nuclear unit at NEMA to handle all nuclear operations' environmental matters in the sector

Socio- economic Issues

- Preparation of guidelines for public consultation and information disclosure
- Preparation of a NPP related resettlement policy framework (RPF) or customize the RPF for Petroleum to meets resettlement needs in the nuclear sector.
- Development of guidelines for access to land for the NPP
- Develop monitoring programmes to ensure full compliance for human rights obligations
- Mainstreaming gender issues and vulnerability in the nuclear sector
- Preparation and implementation of the vulnerable and marginalized groups framework
- Development of a national communication strategy for the nuclear sector and implementation of a public education awareness programme
- Promotion of community development programmes through Corporate Social Responsibility (CSR) projects
- Development and enhancement of Government of Kenya (GoK) security strategy/ master plan of the nuclear sector
- Setting up of a nuclear training fund
- Equitable distribution and allocation of revenue and other benefits from the nuclear sector
- Development of population migrations/influx management plans by ministry of health/ county government health departments in candidate areas and health issues

Occupational Health and Safety

- Develop guidelines for health and safety audit for NPP activities
- Develop strategy to carry out health and safety audit of spent fuel and radioactive waste transportation modes
- Mainstreaming international legal provisions into the local legislation on occupational health and safety
- Development radiation protection standards
- Development of an East Africa regional nuclear policy under East Africa Community
- Establishing Emergency response facilities/ Emergency response organization
- Develop mechanism for emergency notification of nuclear incidents
- There should be a clear set of guidelines and regulations provided with regards to safe distances/buffer zones for developing NPP facilities.
- There is also need to develop a multi criteria decision analysis framework for risk management of the nuclear power sector in Kenya.
- Development of policy guidelines in the relevant codes of practice for OSH Auditing and OSH Performance Monitoring in the nuclear sector. Issues of training, PPE and quality

controls on workplace hazards should be properly instituted to allow full compliance or consequences for non-compliance.

- Harmonization of duplicated roles performed by NEMA, Directorate of Occupational Health and Safety Services (DOSHS), Energy and Petroleum Regulatory Authority (EPRA), and Kenya Bureau of Standards (KEBS) in administering of EHS issues in the energy sector. The lead agencies can conduct joint inspections, investigations, enforcement and monitoring of NPP facilities in compliance with the accepted risk management plan and with the broader legislative framework.
- There is need to enhance the DOSHS human resource and technical capacity for NNP duties. Hiring more inspectors to manage remote areas in particular, for sustainable and equitable enforcement of OSH laws and regulations in all the 47 counties and sub-counties.
- Enhancing public awareness and encourage their participation in monitoring EHS activities of the nuclear sector. Enlightening them on roles they have to play in ensuring their own safety through EHS advocacy programmes. Media used to disseminate information can be achieved through; seminars held on communal or public spaces, learning and religious institutions.
- Radioactive waste vehicle drivers should be trained and educated on safe transportation and handling of such dangerous waste.
- Formulation and implementation of the national nuclear sector disaster risk reduction and emergency response management plan.

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ACRONYMS

AAIK	Action Aid International Kenya
ACA	Athi Catchment Area
ACR	Advanced CANDU Reactor
AHP	Analytical Hierarchy Process
AIDS	Acquired Immunodefieciency Syndrome
ASALs	arid and semi-arid areas
ATPU	Anti-terrorism police unit
BOT	Build Operate Transfer
BWR	Boiling Water Reactor
CANCO	Community Action for Nature Conversation
CEJAD	Centre for Environmental Justice and Development
CEJAD	Centre for Environmental Justice and Development
CHRIPS	Centre for Human Rights and Policy Studies
CIA	Cumulative Impact Assessment
CICC	Coast Interfaith Council of Clerics
CIDP	County Integrated Devlopment Plan
CIPK	Council of Imams and Preachers of Kenya
CJPC	Catholic Justice and Peace Commission
CLMB	County Land Management Boards
CLMP	Community Land Management Plan
CNS	Convention on Nuclear Safety
CORDAID	Catholic Organization for Relief and Development
CPP	Consultation and Public Participation
CPPNM	Convention on the Physical Protection of Nuclear Material
CSO	Community Service Organizations
CSR	Community Social Responsibility
CTBT	Nuclear-Test-Ban Treaty
CTBT	Comprehensive Nuclear Test Ban Treaty
CUE	Commission for Higher Education
DANIDA	Danish International Development Agency
DOSHS	Directorate of Occupational Health and Safety
DPMF	Development Policy Management Forum
DRSRS	Department of Resource Surveys and Remote Sensing
EAC	East Africa Community
EBA	Endemic Bird Areas
ECD	Early Childhood Development
EE	Energy Efficiency
EEZ	Exclusive Economic Zone
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment
EIK	Environmental Institute of Kenya
EMCA	Environmental Management and Coordination Act
ENNCA	Ewaso Ng'iro North Catchment Area
EPR	European Pressurized-water Reactor
ERC	Energy Regulatory Commission
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
FBOs	Faith Based Organizations
FM	Frequency Modulator
GEF	Global Environment Facility
GIS	Geographic Information System
GoK	Government of Kenya
HIA	Heritage Impact Assessment
HIV	Human Immunodefieciency Virus
HLW	high-level waste

HLW	High Level Waste
HPP	Hydro-Power Production
HVDC	High Voltage Direct Current
IAEA	International Atomic Energy Agency
IBA	International Bird Area
IBA	Important Bird Areas
ICZM	Integrated Coastal Zone Management
ILEG	Institute for Law and Environmental Governance
ILW	intermediate-level waste
ILW	Intermediate Level Waste
IPOA	Independent Policing Oversight Authority
IT	Information Technology
ITCZ	Inter Tropical Conventional Zone
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KARA	Kenya Alliance of Resident Associations
KCAA	Kenya Civil Aviation Authority
KEBS	Kenya Bureau of Standards
KEMFRI	Kenya Marine and Fisheries Research Institute
KENGEN	Kenya Electricity Generating Company
KeNHA	Kenya National Highways Authority
KEPSA	Kenya Private Sector Alliance
KEREA	Kenya Renewable Energy Association
KeRRA	Kenya Rural Roads Authority
KETRACO	Kenya Electricity Transmission Company
KEWASNET	Kenya Water and Sanitation Network
KFS	Kenya Forest Service
KIMWASCO	Kilifi-Mariakani Water and Sewerage Company Limited
KISIP	Kenya Informal Settlement Improvement Projects
KNBS	Kenya National Beareu of Statistics
KNDC	Kenya National Electricity Distribution Code
KNEB	Kenya Nuclear Electricity Board
NuPEA	Nuclear Power and Energy Agency
KNETC	Kenya National Electricity Transmission Code
KNPP	Kenya Nuclear Power Programme
KNRA	Kenya Nuclear Regulatory Authority
KPHC	Kenya Population and Housing Census
KPLC	Kenya Power & lighting Company
KRA	Kenya Revenue Authority
KRB	Kenya Roads Board
KRCS	Kenya Red Cross Society
KUP	Kisumu Urban Projects
KURA	Kenya Urban Roads Authority
KWAHO	Kenya Water for Health Organization
KWAWASCO	Kwale Water and Sewerage Company
KWS	Kenya Wildlife Services
KWS	Kenya Wildlife Service
LAPSSET	Lamu Port, South Sudan, Ethiopia Transport Corridor
LAWASCO	Lamu Water and Sewerage Company Limited
LCPDP	Least Cost Power Development Plan
LILW	Low and Intermediate Level Waste
LLW	either low-level waste
LOKADO	Lokichogio Kakuma Development Organization
LVB	Lake Victoria Basin
LVNCA	Lake Victoria North Catchment Area
LVSCA	Lake Victoria South Catchment Area

MAWASCO	Malindi Water & Sewerage Company Limited
MAZIDO	Zones Initiatives & Development Options
MEAs	Multilateral Environmental Agreements
MODIS	Moderate Resolution Imaging Spectroradiometer
MoICNG	Ministry of Interior and Coordination of National Government
MOWASSCO	Mombasa Water and Sanitation Company Limited
MOX	Mixed Oxide
MUHURI	Muslims for Human Rights
MW/KW	Mega Watt/Kilo Watt
NAMA	National Appropriate Mitigation Actions
NASA	National Aeronautics and Space Administration
NBSAP	National Biodiversity Strategy and Action Plan
NCCK	National Council of Churches of Kenya
NCSCs	National & County Security Committees
NEMA	National EnvironmentManagement Authority
NEPIO	Nuclear Electricity Programme Implementing Organization
NGO	Non-Governmental Organization
NLC	National Land Commission
NLUP	National Land Use Policy
NMK	National Museums of Kenya
NPGD	National Policy on Gender and Development
NPP	Nuclear Power Programme
NPT	Non-Proliferation of Nuclear Weapons
NRC	Nuclear Regulatory Commission
NWFZ	Nuclear Weapon Free Zones
NWP	National Water Plan
OHS	Occupational Health and Safety
OSHA	Occupational Health and Safety Act
PGA	Peak Ground Acceleration
PGTMP	Power Generation and Transmission Master Plan
PO2	Plutonium dioxide
PPP	Programmes, Policies and Plans
PPP	Public Private Partnership
PWR	Pressurized Water Reactor
RD&D	Research Development and Dissemination
RE	Renewable Energy
RTA	Reactor Technology Assessment
RVCA	Rift Valley Catchment Area
RVDB	Rift Valley Drainage Basin
SERC	Standards Enforcement Review Committee
SESA	Strategic Environmental Assessment
SESA	Strategic Environmental and Social Assessment
SIA	Social Impact Assessment
SMR	Small Modular Reactor
SRTM	Shuttle Radar Topography Mission
SSAC	State System of Accounting and Control of nuclear materials
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TAC	Technical Advisory Committee
TAVEVO	Tavevo Water and Sewerage Company Limited
TCA	Tana Catchment Area
ToR	Terms of Reference
TuDO	Turkana Development Organizations Forum
TUDOF	Turkana development organization forum
TUPADO	Turkana Pastoralists Development Organization
TVETA	Technical and Vocational Education and Training Authority
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations International Children's Emergency Fund
UO2	Uranium dioxide
UoN	University of Nairobi
USA	United States of America
USAID	United States Agency for International Development
VVER	Water-water energy reactor
WASH	Water and Sanitation for Health
WASPA	Water Services Providers Association
WHO	World Health Organization
WMP	Water Management Plan
WRA	Water Resources Authority
WRI	World Resource Institute
WSSCC	Water Supply and Sanitation Collaborative Council
WSUP	Water & Sanitation for the Urban Poor

DEFINITION OF TERMS

These definitions of terms have been obtained from The Nuclear Energy Regulatory Bill and Environmental Management and Coordination Act, Cap 387. They include:

Clearance Levels - means values established by the Commission and expressed in terms of activity concentrations and/or total activity, at or below which sources of radiation may be released from regulatory control by Commission

Containment - means methods or physical structures that prevent the dispersion of radioactive substances;

Contamination - means the presence of radioactive substances in or on a material or the human body or other place where they are undesirable or could be harmful or the process giving rise to their presence in such places;

Decommissioning - means all steps leading to the release of a facility, other than a disposal facility, from regulatory control other than confirming the decommissioned status of a facility. These steps include the processes of decontamination and dismantling;

Discharges - means planned and controlled releases into the environment, as a legitimate practice, within limits authorized by the Commission, of liquid or gaseous radioactive material that originates from regulated nuclear facilities during normal operation;

Dose Limit- means the value of the effective dose or the equivalent dose to individuals from controlled activities that shall not be exceeded;

Dose- means a measure of the radiation received or 'absorbed' by a target;
Each 'infrastructure milestone' therefore corresponds to the completion of a set of activities, with no implications about the speed with which it is reached

Emergency- Preparedness and Response Plan" means a description of the objectives, policy and concept of operations for the response to an emergency and of the structure, authorities and responsibilities for a systematic, coordinated and effective response;

Environment- includes the physical factors of the surroundings of human beings including land, water, atmosphere, climate, sound, odour, taste, the biological factors of animals and plants and the social factor of aesthetics and includes both the natural and the built environment;

Environmental Impact Assessment- means a systematic examination conducted to determine whether or not a programme, activity or project will have any adverse impacts on the environment;

Exclusive Economic Zone- has the meaning assigned to it by the United Nations Convention on the Law of the SESA

Exposure - means the act or condition of being subject to irradiation;

Facilities - means nuclear facilities or any other location that the authorized person has control over; radiation source facility; radioactive waste management facilities; and any other premises where radioactive material is produced, processed, used, handled, stored or disposed of, on such a scale that consideration of protection of safety is required; also a reactor, critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plan or a

separate storage installation; a reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or any location where nuclear materials in amount greater than one effective kilogram is customarily used;

Infrastructure milestone - is used to identify the point at which the activities required in that phase of development have been successfully completed.

Ionizing Radiation - for the purposes of radiation protection, means radiation capable of producing ion pairs in biological materials;

Milestones- refer to the conditions necessary to demonstrate that the phase has been successfully completed.

Nuclear Energy- means any form of energy released in the course of nuclear fission or nuclear fusion or of any other nuclear transmutation;

Radioactive Waste Management Facility - means a facility and its associated land, buildings and equipment in which radioactive waste is managed.

Radioactive Waste Management- means all activities, including decommissioning activities that relate to the handling, pre-treatment, treatment, conditioning, storage, or disposal of radioactive waste, excluding off-site transportation. It may also involve discharges;

Radioactive Waste- means material, in whatever physical form, remaining from activities or interventions and for which no further use is foreseen (a) that contains or is contaminated with radioactive substances and has an activity or activity concentration higher than the level set for clearance from regulatory requirements, and (b) exposure to which is not excluded under applicable regulations;

Security- means the prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear or other radioactive material, or their associated facilities;

Spent Fuel- means nuclear fuel that has been irradiated and permanently removed from a reactor core;

Strategic environmental assessment- means a formal and systematic process to analyses and address the environmental effects of policies, plans, programmes and other strategic initiatives. In the context of this report, Strategic Environmental Assessment (SESA) and Strategic Environmental and Social Assessment (SESA) are used interchangeably. However, SESA is the international and NEMA official title to the process in Kenya but when referring to this we use SESA.

1 CHAPTER ONE: INTRODUCTION

1.1 Background Information

The national electricity demand is projected to increase significantly in the near future as Kenya gears towards a middle-income economy. Kenya's development footprint, The Vision 2030, has identified energy as a key driver for sustainable growth. The energy sector is expected to provide adequate, affordable and reliable supply of energy to meet the development needs of the country. Kenya's Least Cost Power Development Plan (LCPDP 2017-2037) projects a peak power demand of over 6,638 MW in 2037 as a result of the rapidly increasing use of electricity for industrial, commercial and household use. This has called for the need to enhance and diversify national power generation and supply by identifying new generation and supply sources with a resultant challenge to produce energy that is affordable, reliable, clean and sustainable. Nuclear energy provides such an option as it is most viable for base load operation, is efficient and most importantly, reliable. .

The Nuclear Power and Energy Agency, formerly Kenya Nuclear Electricity Board (KNEB), is a State Corporation established under the Energy Act 2019. It is charged with the responsibility of promoting and implementing Kenya's Nuclear Power Programme, carrying out research and development for the energy sector. Towards attainment of its mandate, the Nuclear Power and Energy Agency shall develop policies and legislation, undertake public education and awareness, identify suitable sites for the construction of Nuclear Power Plants; carry out research, development and innovation on energy technologies as well as capacity building for the energy sector.

In order, to comply with Environmental (Impact Assessment and Audit) Regulations of 2003, NuPEA is subjecting the nuclear power programme to Strategic Environmental and Social Assessment (SESA). The SESA was conducted to present strategic recommendations for the nuclear power programme that are key in this initial decision making and planning stage in order, to ensure the people and the environment are protected. The SESA will assist Kenya to systematically and comprehensively address the unique environmental issues of nuclear power plant operation. This SESA is based on the Strategic Plan for a Nuclear Power Programme, 2013 Programme in Kenya and any other relevant information available including the KNPP Pre-Feasibility Study Report and the Preliminary Reactor Technology Assessment 2015/2016.

1.2 Problem Background

Nuclear power is seen as the technology of choice for satisfying future electricity demand since it ensures safe and reliable electricity production at a reasonable and competitive price, while providing independence from fossil fuel and associated price fluctuations. Uranium fuel represents a relatively small fraction of the cost of nuclear plants' electricity production. As a result, electricity production costs from nuclear plants are not as volatile compared to fossil-fuel based plants. In addition, electricity generation from nuclear produces is associated with almost zero GHC emissions. It is expected that meeting the increasing demand for electricity in the coming decades will require a mix of energy sources that will emit low levels of CO_2 or none-at-all, with nuclear power in an increasingly predominant role.

However, nuclear power has unique characteristics that affect the environment such as accidental radiological releases; risk of radioactive waste and spent fuel leakage; thermal and chemical releases; complexity in the amount of land and time required for construction; the distance of

cooling water intake; the international interest and quality assurance requirements; and decommissioning challenges. These issues should be analysed comprehensively in the context of Kenya's environment.

Principle 7 of the International Atomic Energy Agency (IAEA) Safety Fundamentals, on protection of present and future generations states that '*People and the environment, present and future, must be protected against radiation risks'.* This principle is in consideration that radiation risks may transcend national borders and may persist for long periods of time. Therefore, the possible consequences of current actions have to be taken into account and subsequent generations have to be adequately protected without any need for them to take significant protective actions. By conducting the SESA, this principle will be applied in this initial stage of nuclear power programme planning.

1.3 Strategic Environmental and Social Assessment

Nuclear reactors are listed in the Second Schedule of EMCA cap 387 as one of the projects likely to have a cumulative significant negative environmental impact. Prior to 2015, the only legal provision for Strategic Environmental and Social Assessment (SESA) was through Regulation 42 and 43 of the 2003 Environmental (Impact Assessment and Audit) Regulations. With the 2015 amendments to EMCA Cap 387, the law provides a mandatory requirement for SESA, to be undertaken by the responsible entities, with respect to all policies, plans and programmes (PPPs) as prescribed in Sections 41-50. Section 57 A states that, "All Policies, Plans and Programmes for implementation shall be subject to Strategic Environmental Assessment." Section 41 (1) states that the Authority shall in consultation with county governments, lead agencies, institutions and private entities subject all proposals for policy, plans or programmes to a Strategic Environmental Assessment to incorporate environmental considerations for sustainable development. Section 41 (2) specifies that the objectives of a Strategic Environmental and Social Assessment study shall be to: (a) guide policy, programme or plan proposals to ensure they are compatible with sustainable environmental planning and management. The law requires that all entities undertake or cause the SESA to be undertaken, at their own expense, and shall submit such assessments (SESA report) to NEMA for approval. In addition, NEMA is required to consult with lead agencies and relevant stakeholders to prescribe rules and guidelines in respect of Strategic Environmental and Social Assessments.

UNEP, 2002 defines SESA is a family of approaches that uses a variety of tools, rather than a single, fixed, prescriptive approach. The SESA process extends the aims and principles of Environmental and Social Impact Assessment (ESIA) upstream in the decision-making process, beyond the project level, when major alternatives are still possible. Consistent with Agenda 21 principles, SESA is a proactive approach to integrate environmental and social considerations into the higher levels of decision-making.

1.4 Basic Principles for SESA

The Environmental (Impact Assessment and Audit) Regulations of 2003 provide for SESA in compliance to the following principles:

- The sustainable use of natural resources;
- The enhanced protection and conservation of biodiversity;
- Interlinkages between human settlements and cultural issues;
- Integration of socio-economic and environmental factors;
- The protection and conservation of natural physical surroundings of scenic beauty and the protection and conservation of built environment of historic or cultural significance;
- Public and stakeholder engagement;

1.5 Purpose and Objectives of the Nuclear Power Programme SESA

The purpose for the SESA as per the Terms of Reference is to assist Kenya systematically and comprehensively address the unique issues of nuclear power programme based on the Strategic Plan for Nuclear Power Programme 2013 for Kenya and any other relevant information.

The SESA objectives as per the Terms of Reference (attached as Annex I) are as follows: -

- To ensure sustainable use of natural resources in the implementation of the nuclear power programme
- To devise mechanisms to ensure enhanced protection and conservation of biodiversity, natural environment and built environment in the activities of the programme
- To ensure integration of socio-economic and environmental factors in the nuclear power programme
- To ensure public/ stakeholder participation in the decision-making process for Kenya's nuclear power programme.

1.6 Scope and Structure of the SESA

1.6.1 Study Scope

The broad scope for the Nuclear Power Programme SESA as per the Terms of Reference directed the Consultant undertake consultations and workshops with interested parties. The reports thereof for submission to NEMA was expected to -

- Identify key economic, social and ecological issues regarding Kenya's nuclear power programme
- Draft a list of key environmental issues associated with Kenya's Nuclear Power Programme
- Assess the likely impact on ecological systems resulting from constructing and operating a nuclear power plant

The assignment was undertaken with considerations to the requirements for EMCA Cap 387 and the National Guidelines for Strategic Environmental Assessment 2012 as outline by the following tasks: -

- **Task 1**: Preparation of the scoping report
- **Task 2:** Submission of a SESA scoping report to NEMA
- **Task 3**: Undertaking the SESA study
- **Task 4:** Ensuring quality assurance of the draft SESA report
- **Task 5:** Submission of the Draft SESA report to NEMA
- **Task 7:** Publishing of public notices in the Kenya Gazette and local newspaper of countrywide circulation for the Public to Submit Comments on the Draft Strategic
- Environment Assessment Report
- **Task 8:** Review of the draft SESA report
- **Task 9:** Validation workshop
- **Task 10:** Preparation of the final SESA report
- **Task 11:** Submission of report to NEMA
- **Task 12:** Obtaining of the approval of the SESA report

1.6.2 Geographical and administrative boundary

The SESA covered the whole of Kenya. However, special focus was given to the candidate areas mapped as technologically potential for Siting the Nuclear Power Plant based on the availability of cooling water. The most suitable geographic areas for this purpose are the Coastal Region, Lake Victoria Basin and the Tana River Basin as highlighted in the NPP Pre-Feasibility Study Report (page 274, par 1). Stakeholder consultations and focus of the SESA were consequently focussed on the Lake Victoria, Rift Valley and Tana River basins and the Coast region.

Temporal boundaries refer to programme lifespan and the reversibility of impacts. A review of impacts for classification during the SESA study for NPP was summarized as follows:

- *Short term impacts*- occurring during construction phase of NPP components;
- *Medium term impacts*- occurring during operation. The typical lifetime of operating nuclear plants is 20 to 40 years; and
- *Long-term impacts*- occurring beyond the planning horizon up to 2030 and after decommissioning of any associated components. This can last up to over 50 years post decommission for plants where radioactive wastes involved are high level.

1.7 Institutional boundaries

The administrative or institutional boundaries in which a project lies or interacts with include the following:

- National political administration;
- County administrations in the drainage basins identified as having potential to host nuclear plants;
- Government ministries and lead agencies with specific mandates to manage provision of energy and national security;
- Regulatory agencies with specific mandates on elements triggered by the NPP. Examples include the Water Resources Management Authority, Directorate of Occupational Safety and Health Services, National Environment Management Authority, Nuclear Regulatory Authority and the Kenya Wildlife Service.

1.8 Methodology and Criteria for undertaking the SESA

The SESA was carried out in line with the provisions of the Environmental Management and Coordination Act, (EMCA, Cap 387), the Environmental (Impact Assessment and Audit) Regulations 2003, Draft Environmental Management and Coordination (Strategic Assessment, Integrated Impact Assessment and Audit) Regulations 2018, the 2012 National Guidelines for Strategic Environmental Assessment in Kenya, as well as international guidelines on SESA.

Generally, the SESA process was phased into two: Phase 1 – Screening and Scoping, and Phase 2 – the SESA Study. The Screening and Scoping Phase was aimed at establishing the spatial and technical focus and content of the SESA and the relevant criteria for assessment. The purpose of the SESA is to identify, describe and assess at a strategic level the environmental and socio-economic opportunities/constraint of implementing the proposed programme. Further, the SESA process developed practical mitigation measures (strategic recommendations) for addressing the identified limitations and gaps as well as the enhancement of opportunities. The SESA is intended to ensure that environmental and social considerations are included in the planning, implementation and operation of the proposed Programme.

The main activities in the SESA study included:

- Description of the proposed Programme including the objective, purpose, and rationale;

- Identification of alternative options and strategies, implementation of the Programme and time scale;
- Areas and sectors affected by the proposed Programme;
- Field missions for baseline environmental and socio-economic analysis;
- Collection of baseline data including data on ecological processes and services, resilience and vulnerability of these processes and their significance to human well-being;
- Review and analysis of compliance with existing policy and legislative frameworks for environmental protection and existing environmental protection programmes and their objectives;
- Review of the level of integration in the proposed programme of other relevant development plans/programmes for the area within the study boundaries;
- Identification of alternatives options and justification of preferred alternatives and linkages between any ongoing activities and proposed plan/ programmes;
- Integration of climate change vulnerability assessment, adaptation and mitigation actions;
- Prediction and evaluation of impacts, including cumulative effects;
- Preparation of an Environmental and Social Management and Monitoring Plan (ESMMP);
- Institutional strengthening/capacity building;

1.9 Kenya Nuclear Power Programme (NPP)

Kenya has been a member State of the IAEA since 1965. The IAEA is an inter-governmental agency, which ensures that member States comply with their obligations to use nuclear energy for peaceful purposes only. Various conventions and treaties dealing with nuclear energy use have been ratified by Kenya with the IAEA, including Comprehensive Safeguards Agreement, Additional Protocol and Small Quantities Protocol in 2009 (KNEB Strategic Plan, 2014).

Hence in development of the national nuclear power programme, Kenya will be guided by the IAEA's Milestone Approach as highlighted below. According to IAEA, 2015 (*(IAEA: No. NG-G-3.1 (Rev. 1),* A nuclear power programme is a major undertaking requiring careful planning, preparation and investment in time and human resources. While nuclear power is not alone in this respect, it is considered different because of the issues associated with the possession and handling of nuclear material. Therefore, this needs a national commitment statement in regards its safe and peaceful use for electricity power generation.

The activities needed to prepare the infrastructure for nuclear power programme are split into three phases, with the duration of each dependent on the degree of commitment and resources applied in the country. The development and implementation of an appropriate infrastructure to support the successful introduction of nuclear power and its safe, secure, peaceful and sustainable application is an issue of central concern to Kenya, being the first NPP for consideration and planning. In preparing the necessary nuclear infrastructure, there are several activities that need to be completed, split into three progressive phases of NPP development.

The three phases in developing the infrastructure necessary to support a nuclear power programme in Kenya are:

- Phase 1: Considerations before a decision to launch a nuclear power programme is taken;
- Phase 2: Preparatory work for the contracting and construction of a nuclear power plant after a policy decision has been taken;
- Phase 3: Activities to implement the first nuclear power plant.

The completion of each phase is marked by a specific milestone at which the progress of the development effort can be assessed, and a decision can be made to move on to the next phase.

The following milestones are necessary in the three phases:

- Milestone 1: Ready to make a knowledgeable commitment to a nuclear power programme;
- Milestone 2: Ready to invite bids/negotiate a contract for the first nuclear power plant;
- Milestone 3: Ready to commission and operate the first nuclear power plant. **Figure 1-1** is a schematic representation of the phases and milestones (IAEA, n.d.).

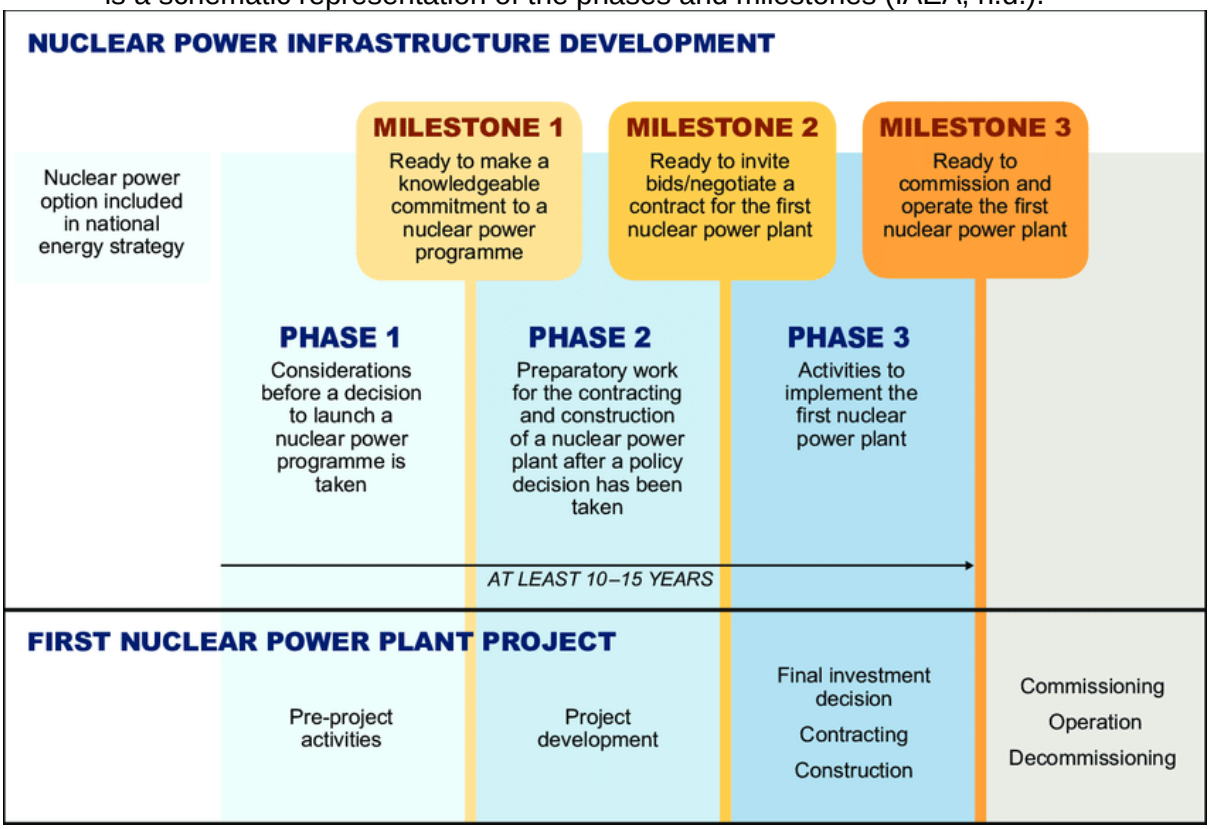

Figure 1-1: Typical NPP development chart
Source: IAEA, 2007

1.10 Work Plan for executing the SESA

1.11 SESA Time Schedule

The entire Strategic Environmental Assessment, starting from data collection to submission of the Final SESA Report to NEMA and approval, was undertaken as per EMCA Cap 387 and National SESA Guidelines of 2012.

Table 1-1 below presents a summary of the key activities that were followed.

Table 1-1: SESA work plan

Report Due/Activities	weeks				
	1-4	5-8	9-12	13-20	
Task 1: Mobilization period / SESA Screening and Scoping/ Development of data collection tools/ TORs- Drafting of the Programme Brief for NEMA Approval					
Task 2: Detailed Description of the Proposed Programme					
Task 3: Detailed Description of the Environment/ Baseline Surveys					
Task 4: Analysis of the Legislative and regulatory Considerations					
Task 5: Determination of the Potential Impacts of the Proposed Programme					
Task 6: Analysis of the Alternatives to the Proposed Programme					
Task 7: Development of the Environmental Management Plan to Mitigate Negative Impacts/Concerns					
Task 8: Development of Environmental Monitoring Plan					
Task 9: Identification of Institutional Needs to implement SESA Recommendations					
Task 10: Public Consultations and Public Participation					
Task 11: Final SESA Report Compilation, Review and Final Submission to Proponent/ Developer and NEMA					
Task 12: Processing and Approval of Final SESA Report					
Approvals = Within 20 weeks from the date of commencement					

Source: SGS, 2019

1.12 Budget to implement the SESA

NuPEA is committed to facilitate financial, administrative and technical resources to see the SESA process from scoping into implementation stage. The proponent also provided access to Programme details, various project information and obliged to facilitate consultative meetings among key SESA consultants, technical teams and stakeholders.

The source of funding for the SESA study is the Government of Kenya but the financing aspect of the NPP is among the plans underway with a Build Operate Transfer (BOT) being the most preferred financing agreement with the concessionaire that shall come on board.

2 CHAPTER TWO: THE KENYA NUCLEAR POWER PROGRAMME DESCRIPTION

2.1 Introduction

This chapter highlights the purpose, rationale and objectives, the Kenya Nuclear Power Programme. It gives a detailed analysis of alternative plans. Areas and sectors likely to be affected by the KNPP are also highlighted in the succeeding sections. Kenya has been a member State of the IAEA since 1965. The IAEA is an inter-governmental agency which ensures that member States comply with their obligations to use nuclear energy for peaceful purposes only. Various conventions and treaties dealing with nuclear energy use have been ratified by Kenya with the IAEA, including Comprehensive Safeguards Agreement, Additional Protocol and Small Quantities Protocol in 2009 (KNEB Strategic Plan, 2014). Hence the development of the Kenya Nuclear Power Programme (KNPP), will be guided by the IAEA's Milestone Approach as shown in this section and also in Chapter One (1) above.

2.2 The Rationale of the KNPP

Nuclear power has been proposed by the GoK as one of the possible technologies of choice for future electricity generation to cater for the growing power demand. If well managed, the government sees that this can provide relatively safe and reliable electricity production at a reasonable and competitive price, while at the same time providing independence from fossil fuel and associated price fluctuations. The NuPEA as the Nuclear Energy Programme Implementing Organization (NEPIO) proponent of nuclear power highlight the following advantages for this approach.

The purpose of the KNPP as indicated in the KNEB Strategic plan for the NPP in Kenya, 2013 and NPP pre-feasibility study, 2014 is to ensure that the objectives in the national development blueprint, the Kenya Vision 2030 are achieved. In this course, the Ministry of Energy developed the Least Coast Power Development Plan (2017-2037) that acknowledges the position of NPP in ensuring power stability and reliability in Kenya towards national sustainable development. The key argument is that energy is at the heart of any economic transformation. Despite the growing energy consumption patterns, the Kenyan economy has experienced rapid and persistent rise in energy prices that have had far reaching consequences. Poor households bear the greatest brunt of energy price increase. Not only are they forced to pay higher prices, but also find modern energy out of their reach, thus opting for 'dirty' and health-risk traditional energy forms such as charcoal, firewood and kerosene.

Higher power prices also wear away Kenya's manufacturing sector competitiveness regionally and globally, thereby denying the domestic industries of revenue. The Kenya Association of Manufacturers (KAM) in 2017 pointed that the manufacturers domestically pay electricity tariff of Ksh 15 per kilowatt hour. This is more than double what they pay in Ethiopia and Egypt at Ksh 4 and Ksh 6 per kilowatt hour, respectively. Industries in South Africa pay a tariff of Ksh 9 per kilowatt hour. Among the East African counterparts, manufacturers in Uganda and Tanzania face a tariff of Ksh 12 and 14 per kilowatt hour, respectively. Higher energy costs are also prohibitive to prospective investors and erodes Kenya's image as a destination hub for investments. All these greatly hamper Kenya's quest to expand her manufacturing sector and further entrenches poverty as job opportunities shrink.

The justification to plan and implement a NPP in the country are anchored upon the following benefits: -

- ***Competitive price of Nuclear Power:*** Nuclear energy is considered cost competitive compared to fossil fuel-based generation, even though it involves relatively high upfront investment costs and to stringent standards for safety and security, emergency management, decommissioning and nuclear waste management. On a comprehensive basis, taking into account socio-political health and environmental costs, the economics of nuclear power are considered attractive by some, for instance as compared to fossil fuel.

- ***Base load generation and fuel availability:*** Nuclear power plants are operated at base load which provides stable and continuous availability of electricity. Uranium availability is not a limiting factor and the cost of uranium fuel is lower and less volatile as compared to fossil fuel.

- ***Low Carbon emissions:*** The complete nuclear electricity generation produces limited greenhouse gases as compared to fossil fuel-based energy production. Future electricity generation in the coming decades will require energy mix sources, which emit low levels of greenhouse gases or none at all. This, the NEPIO says, therefore makes nuclear energy one of the energy options for climate change mitigation. Nuclear can be adopted as one of the Nationally Appropriate Mitigation Actions (NAMAs) for climate change in Kenya.

2.3 Nuclear Electricity Development in Kenya

According to Kenya Nuclear Power Development Plan and NuPEA's View, the first Nuclear Power Plant of 1,000 MW, is expected to be commissioned by the year 2027 and it is expected to grow to 4,000 MW by 2035. Identified potential technologies are considering the installation preferably of 1,000 MW nuclear power reactor. The latest technology nuclear reactors available in the international market are large sized reactors in the range 1,000 – 1,750 MW with proven design technology, experience and performance records.

The KNPP is currently undertaking reactor technology assessment to identify the ideal reactor for the country based on the existing technologies in the market. These alternative reactor technologies are discussed in this SESA report and were generally subjected to environmental and social assessment. Other ongoing activities include site selection phase 2, public awareness, human resource development, development of nuclear sector policies and legal instruments. The reactor capacity, land and water requirements, reactor fuel demand, safety and emergency management requirements, radioactive waste and decommissioning issues were considered in the stakeholder engagement. This was also done against the existing environmental and social PPPs in order to identify framework gaps that will have to be progressively filled.

2.3.1 Brief Description of Nuclear Energy

Nuclear power is sustainable, environmentally friendly, economically competitive and safe, in comparison to other power sources. Nuclear power has its own distinctive elements which make it unique such as:

i) Sustainable Energy: As the availability of fossil fuels decline and greenhouse gases emission concerns rise, the global challenges are to develop strategies that foster a sustainable energy future which is less dependent on these fuels. One of the options available for a more sustainable energy source is nuclear power, which is proven and environmentally friendly, as electricity production from nuclear power generates almost zero emissions.

ii) Economically Competitive: Nuclear power is a sustainable energy source. Its raw material reserves are extensive and available in many continents. It has a long-term operational life of typically 60 years for current designs. Nuclear power also has a small footprint since land usage is comparably low. Nuclear power plants are expensive to build but relatively inexpensive to operate because of less usage of fuel per unit output. This results in an economically competitive source with predictable electricity generation costs and the potential for fuel recycling.

iii) *Technology:* Nuclear technology is complex and unique; therefore, there are a limited number of suppliers. These increased costs and timescales associated with development of a KNPP and construction of a nuclear facility means that nuclear power requires a long-term commitment.

iv) *Public Perceptions:* Nuclear power can be a sensitive issue. The sector is characterized by widespread fear and social stigma which is largely driven by lack of awareness and misunderstanding. Trust among the public and other stakeholders is therefore highly important. Promotion of a nuclear expertise for safety, in relation to radiation, radioactive waste, spent fuel and decommissioning, can aid understanding and reinforce a positive attitude towards nuclear power.

v) *Nuclear Safety, Security & Safeguards:* When considering nuclear power, a fundamental requirement must be the protection of people, property, society and the environment from radiation. This includes proper management of radioactive materials, radioactive waste and spent nuclear fuel.

vi) *International Cooperation:* International Cooperation is necessary for international confidence, non-proliferation and potential cross-border impacts, in the event of a nuclear incident or accident. Cooperation is necessary to share information, experience and to promote cooperation. It is also important for building trust with neighbouring countries.

Advantages of Nuclear Energy

- Low carbon emissions
- Stable and reliable power supply
- Affordable electricity
- Low fuel cost
- Low operation and maintenance cost
- Generate minimal waste
- Advanced technology – with additional safety features

Disadvantages of Nuclear Energy

- High capital cost
- Risk of exposure to nuclear radiation
- Management of radioactive waste
- Risk of nuclear incidents and accidents

2.3.2 Typical Design of a Nuclear Power Plant

Nuclear power plants, like conventional power plants using fossil fuels, produce electricity by heating water into steam. The steam is then introduced in a turbine which drives an electrical generator. These, however, are the only similarities between nuclear and conventional power plants. The conventional thermal power plants burn gas, oil or coal while nuclear power plants rely on the fission (splitting) of elements such as uranium and plutonium into smaller elements called fission products.

During the fission process, a considerable amount of energy is released. Neutrons are also released and if captured by other fissile atoms can prompt further fission, creating a chain reaction. This chain reaction is controlled using neutron absorbers allowing for a constant fission rate. The energy released from continuous fission in the fuel is used to make steam, which is used to drive the turbine-generator to produce electricity. Fission generates significantly more energy than the burning of fossil fuels, especially on a pound per pound basis.

2.3.3 Typical Components of a nuclear reactor

The fuel, usually in form of pellets of uranium oxide (UO_2) arranged in tubes to form fuel rods. The rods are then arranged into fuel assemblies in the reactor core. Uranium can be used in its natural form or can be enriched to increase the content of fissile material. Other possible fuel types include MOX (Mixed Oxide) fuel and thorium-based fuels. Natural uranium contains only 0.7 % of the fissile isotope uranium-235 (U-235), the rest being uranium-238 (U-238). Without the use of a low absorber such as heavy water, a chain reaction cannot be sustained with natural uranium. Therefore, reactors which employ regular water as moderator, use enriched fissile material (up to 5% U-235) in the fuel to compensate for the higher neutron absorptions. MOX fuel is a mixture of uranium dioxide (UO_2) and plutonium dioxide (PuO_2) and consists of plutonium mixed with depleted uranium. MOX fuel is produced from plutonium recovered from spent fuel, and it is the preferred fuel choice for fast neutron reactors. Plutonium is progressively bred in any nuclear reactor from non-fissile U-238 which comprises over 99% of natural uranium. Thorium can also be used as a nuclear fuel through breeding to uranium 233. Thorium 232 will absorb slow neutrons to produce uranium 233, which is a fissile and long-lived isotope. All mined thorium is potentially useable. The Canadian Deuterium Uranium CANDU reactors (see types of reactors) are currently the only reactors able to employ thorium as a fuel. During operation of the reactor the concentration of fissile atoms in the fuel decreases as those atoms are depleted in the fission reactions. The products created by fissions are retained within the fuel pellets and at some point; this will affect the effective utilization of the remaining fissionable fuel. Replacement of some of the fuel can be done, either "on-line" (i.e. with the reactor in operation) or during a temporary reactor shutdown (typically a few weeks), depending on the reactor design.

The coolant or moderator which is a liquid or gas circulating through the reactor core used to transfer heat from the fuel rods to the turbine-generator, either in a direct cycle (such as Boiling Water Reactor, see below) or indirect cycle via a steam generator (other water reactors and current commercially operating gas reactors). The circulating coolant also provides a moderating function to improve the efficiency of the neutron fission process in current commercial power reactors. The moderator slows down the neutrons released from fission, increasing their chance of capture by a fissile atom. In most reactor design, water is used as coolant and moderator. In light water reactors, the water functions as moderator and as primary coolant. In some reactors, a separate moderator is used (e.g. heavy water in CANDU reactor or graphite in RBMK reactor). The choice of moderator influences the design of the reactor core and fuel cycle, particularly the amount of enrichment of fissile uranium during the fuel rod production process, the amount of energy that can be extracted from each fuel rod and the size (power density) of the reactor core.

The control rods are inserted or withdrawn from the core to control the rate of fission. They are made of Cadmium, Boron or other elements known for their propensity to absorb neutrons. As a means of increasing safety (in the case of control rods failure), reactor designs include secondary shutdown systems which involve adding other neutron absorbers (such as Boron) into the primary cooling system.

The pressure vessel, usually of robust steel, contains the reactor core and moderator/coolant, but it may also be a series of pressure tubes holding the fuel and conveying the coolant through the surrounding moderator (e.g. as CANDU and RBMK).

The primary circuit conveys coolant from the reactor core either directly to the turbine-generator (e.g. Boiling Water Reactors, BWR) or to a steam generator (e.g. Pressurized Water Reactors, PWR). After the heat transfer, the coolant is returned to the reactor core in a closed cycle. Attached to the primary circuit are a number of auxiliary “primary systems” which are used for chemistry (corrosion) and volume control of the coolant. Some reactor designs (e.g. PWR) are based on prevention of phase change (boiling) in the primary circuit and incorporate a pressurizer to suppress boiling. This allows the circulating water and steam at the turbine to hold more energy per unit volume which increases the efficiency of energy transfer in nuclear power plants containing a secondary circuit. These designs are those that have an intermediate steam generator and separate secondary (steam-feed water) circuit supplying steam to the turbine-generator. Some new reactor technologies (e.g. Generation IV) aim at using the discharge heat from an intermediate circuit for industrial and residential heating purposes.

The turbine (one or several) converts the steam into kinetic energy which drives an electricity generator. Roughly, a third of the generated heat energy can be converted to electrical energy. The excess heat is usually released into the environment. From the turbine, the steam is led to the condensers, where it condenses back into water. The water used for cooling in the condensers warms up by a few degrees Celsius and is either discharged to a body of water or led to cooling towers. Water, which circulates inside the reactor primary circuit, may contain small quantities of fission and activation products, but this water is not mixed with the condenser cooling water at any time. The steam generator is a part of the cooling system of pressurized water reactors (see types of reactors) where the high-pressure primary coolant bringing heat from the reactor is used to produce steam for the turbine, in a secondary circuit. Reactors have up to six 'loops', each with a steam generator.

The containment around the reactor and some parts of the primary circuit and safety systems (extent depending on reactor design), is designed to protect it from outside intrusion and to protect those outside from the effects of radiation in case of any serious malfunction events. It is typically a metre-thick concrete lined with steel. In modern reactor designs, the containment is designed to withstand for example the impact of a crashing aircraft. Some designs incorporate two containment shells. Figure2-1 below shows the typical components of a nuclear reactor.

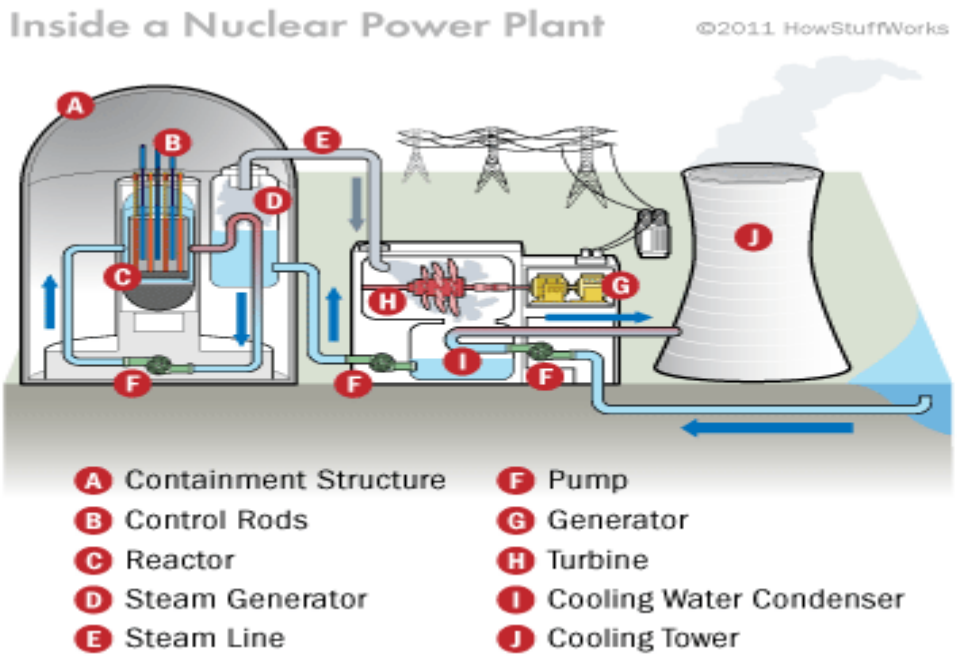

Figure2-1 : Typical Components of a nuclear reactor
Source: KIGER, 2019

2.3.4 Evolution of the Nuclear Power Technology

Since the first commercial exploitation of civil nuclear power, the nuclear reactor technology has changed considerably. This technological development is presented as a number of 'generations' of nuclear reactors, each representing a significant technical advance, in terms of performance, costs, or safety, compared to the previous generation as seen in **Figure 2-2: Evolution of the nuclear power technology Nuclear Reactor Capacity**.

- The Generation I reactors were developed in 1950-60s. They mostly used natural uranium fuel, were gas-cooled and used graphite as moderator.
- The Generation II reactors typically use enriched uranium fuel and are the standard light-water pressurized and boiling water reactors in operation today.
- The Generation-III reactors are under construction in several countries and have, compared to current light-water reactors, improved performance and extended design lifetimes, and more favourable characteristics in the event of extreme events such as those associated with core damage. A typical example is the European Pressurized-water Reactor (EPR).

Generation IV designs are still on the drawing board and will not be commercially operational before 2040. They are proposed to burn the long-lived actinides now forming part of spent fuel and aim to increase fuel utilization to extract 50 times more energy than current reactors from a given quantity of uranium. At the moment, when minor actinides are separated from the spent fuel, they end up in the waste, where they are responsible for much of the heat and radiation produced by the waste in the long term. By burning them in the reactor, they can be transmuted into less radiotoxic and shorter-lived radionuclides. Six designs are currently being investigated of which four will be fast neutron reactors. Most of these technologies are designed to run at much higher temperatures than today's water-cooled reactors and aim at solving specific technical challenges on safety, proliferation resistance, economics, etc. (Aly et,.al, 2014)

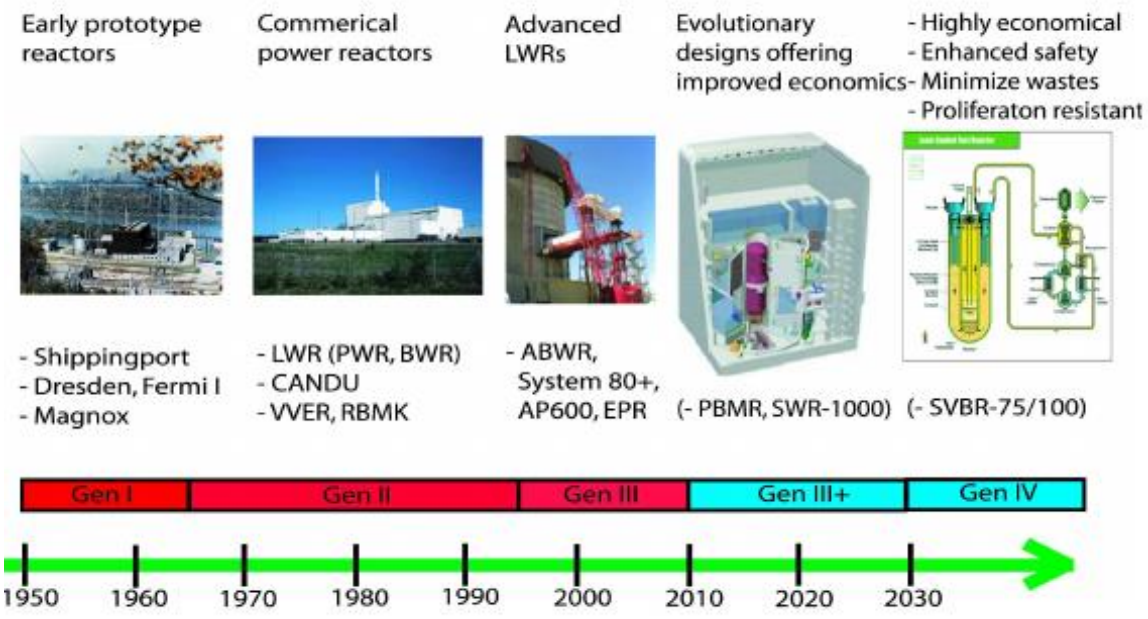

Figure 2-2: Evolution of the nuclear power technology Nuclear Reactor Capacity
Source: Aly et,.al (2014)

According to the Power Reactor Information System (PRIS), developed and maintained by the IAEA, there are 441 operating reactors worldwide accounting for a nominal capacity of 390 113

MW_e. Depending on the specific site of construction and reactor technology, the reactor power of a single unit can vary considerably.

2.3.5 Lifetime of Nuclear Reactors

The typical lifetime of operating nuclear plants is 20 to 40 years, but with proper management and safety enhancements, their lifespan maybe extended to 60 years of operation according to IAEA. An increasing number of operators and regulators have started looking at the option of extending the nuclear power plant operation. To increase the lifespan of a nuclear power plant, major investments in systems, structures and components of ageing nuclear power plants are needed to maintain reliability and safety.

It should be noted that an important issue is knowledge management over the full lifecycle of the nuclear reactor, from design, through construction and operation to decommissioning. This may span a century and will cover several generations of engineers. Data needs to be transferable across several generations of software and IT hardware, as well as being shared with other operators of similar plants.

2.3.6 Requirement land and water

The required installation area will depend on the reactor design, reactor capacity and site location, but in principle, about 1 to 4 km^2 area is required for the construction and operation of a nuclear power plant. The nuclear power plant site includes several buildings and structures such as reactor containment and auxiliary buildings, operating waste treatment building, fresh fuel storage, interim storage for spent nuclear fuel, storage for low- and intermediate-level waste, control room building, back-up power generators, electric building, turbine building, water pumping station, water treatment structures, administrative buildings, fire station, etc.

Nuclear power plants, like another condensing power plants, needs cooling water. Most nuclear power plants use one of the following two types of cooling water systems, namely, the once-through cooling system or the recirculating cooling system.

The once-through or open cooling system withdraws a large amount of water from a nearby large water surface body (i.e. the sea, a big river, or large inland water body) and runs it through the condensers in a single pass and discharging it back into the sea, lake or river a few degrees warmer and without much loss from the amount withdrawn. Because the temperature of the water leaving the installation is higher, it must be discharged at a sufficient distance from the intake point so that it may mix with the ambient waters in the area and so that heated water does not return at the intake point. The water may be salt or fresh. Some small amount of evaporation will occur off site due to the water being a few degrees warmer.

The recirculating or closed cooling system uses a cooling tower and is mostly considered if there is no access to abundant water. After passing through the condenser, the heated water moves through the cooling tower, where an up draught of air through water droplets cools the water. Sometimes an on-site pond or canal may be sufficient for cooling the water. Wet cooling tower can be either natural or forced draft type. Normally the cooling is chiefly through evaporation, with simple heat transfer to the air being of less significance. The cooling tower evaporates up to 5% of the flow and the cooled water is then returned to the power plant's condenser. The 3 to 5% or so is effectively consumed and must be continually replaced.

The cooling water use will vary in proportion to the amount of energy produced and depend on the reactor design. According to data found in literature for Western Europe, the maximum demand of a 3750 MWe nuclear power plant with a once-through cooling system is between 124 m^3/s to 210 m^3/s while for a recirculating cooling system, it is 3.2 m^3/s do 4.2 m^3/s due to water loss recuperation and desalination discharge. There is also water needed as potable water and for preparing the plant’s process waters. Maximum consumption of service water is around 0.2 m^3/s. The water requirements of a nuclear power plant are about 15 to 25% higher that of a coal

fired power plant. Given the tropical climate, the water requirement for a nuclear power plant in Kenya will probably higher than for a nuclear power plant in Western Europe.
There is also another cooling system, namely the dry cooling system. When access to water is limited, or environmental and aesthetic considerations are prioritized, dry cooling techniques may be chosen. This system relies on air as the medium of heat transfer, rather than evaporation from the cooling circuit. Dry cooling means that minimal water loss is achieved. However, in a tropical climate the ambient air temperature may be 40 °C, which severely limits the cooling potential. In the UK, it has been ruled out as impractical and unreliable (in hot weather) for new nuclear plants. For this reason, dry-cooling systems or systems using air and other gases will not be taken into consideration in this study.

Nuclear power plants, like other conventional water-cooled thermal power plants, are vulnerable to conditions of water scarcity and climate change. In areas where water scarcity is already a concern, non-thermal technologies or other thermal technologies using dry cooling without additional stress on water resources should be considered. The water availability and water-use permitting should be taken into consideration during the siting process.

2.3.7 Reactor fuel

In most reactors, the fuel is ceramic uranium oxide (with a melting point of 2800 °C) and for most reactor designs is enriched in the U-235 content up to 5%. The fuel pellets (usually about 1 cm diameter and 1.5 cm long) are typically arranged in fuel rods. Numerous rods form a fuel assembly, which is an open lattice and can be lifted into and out of the reactor core. A BWR fuel assembly comprises 60-100 fuel rods (i.e. lattices from 8x8 to 10x10) and each assembly holds about 200 kg uranium, a PWR has fuel assemblies of 200-300 rods each (i.e. 14x14 to 17x17) and holds roughly 500 kg uranium. Depending on the power size, a BWR reactor would hold up between 600 and 1100 assemblies, while a PWR reactor would have about 150-250 fuel assemblies.

The thermal efficiency of a nuclear power plant is 33% to 36%; this means that around 3,000 MW of thermal power from the fission reaction are needed to generate 1,000 MW of electrical power (MWe). About 3.2 kg of the fissile U-235 per day is needed by a 1000 MWe nuclear power plant. For comparison, a 1000 MWe coal-fired power plant, which has thermal efficiency comparable to that of a nuclear power plant, burns about 8,000 tons of coal per day.

The amount of energy extracted from nuclear fuel is called “burn up” and it is expressed in terms of the energy produced per tonne of uranium fuel weight or tonne of heavy metal (commonly GWd/tU or GWd/tHM). Current light water reactors typically achieve average burn ups in the range of between 40 and 50 GWd/tU, but with newer fuel technology and the use of nuclear poisons these reactors are capable of achieving up to 60 GWd/tU. The Candu reactor burn ups are around 7 to 8 GWd/tU, while the Advanced Candu Reactor aims to achieve 20 GWd/tU. Some more-advanced light-water reactor designs are expected to achieve over 90 GWd/tU using fuel with higher enrichment. The higher the burn up, the less spent fuel is produced. However, this benefit is, at least partly, offset by the higher expenses required for the development of fuel capable of sustaining such high levels of irradiation. The nuclear reactor needs to be refuelled at regular times because fission products build-up in the fuel and poison the fission chain reaction.

Most nuclear power plants need to be refuelled every 18 to 24 months, which denotes the cycle of the reactor. At each cycle, between 25 to 50% of the fuel assemblies, which contain the uranium and plutonium undergoing fission, are removed and replaced with new fuel assemblies. In the early days of the nuclear energy industry, most nuclear power plants were on 12-month cycles, but with better reactor designs and increased fuel enrichment, these cycle times have been extended. The improvements to the reactor designs led to increase in the plant efficiency and therefore the reactors are able to harness more energy from the same fuel quantity. Because the

fuel will remain on the same location in the reactor for up to 24 months, placement within the nuclear reactor is very important. Nuclear engineers start preparing each cycle up to a year and a half in advance to determine how many new fuel assemblies are required, what the uranium enrichment should be and where the fuel assemblies should be located within the core. Most reactors have to shut down for a few weeks during the refuel process. Some reactor designs, such as CANDU reactors, can be refuelled without being shut down.

2.3.8 Radioactive Waste Management

During the operation of the nuclear reactor, three types of radioactive waste (high level, intermediate and low-level waste) are produced. The high-level waste (HLW) is notably spent fuel or waste arising from reprocessing the spent fuel. It is hot and highly radioactive due to decay heat, so it requires cooling and shielding. Storage in special cooling ponds at the reactor site as prescribed in the nuclear regulations is normally foreseen so that heat and radioactivity can decay to levels which make handling and storage easier. The spent fuel contains depleted uranium as well as significant quantities of transuranic actinides (mainly plutonium and curium). In addition, about 3% of the spent fuel is fission products from fission reactions.

The high-level waste is a major issue because it remains hazardous for a long time due to the long half-life of the actinides (uranium, plutonium, and curium). Because the spent fuel still contains useable fissile material, reprocessing the spent fuel is also considered. During reprocessing, uranium and plutonium are chemically separated from the other fission products and minor actinides which remain in the waste. Reprocessing can potentially recover up to 95% of the remaining uranium and plutonium in spent nuclear fuel. As such, it can reduce the radiotoxicity of the remaining waste by over 90%. Qua volume it can create a reduction of the HLW up to 50%, but it increases the volume of ILW. Up to now, about one third of spent fuel from commercial power reactors has been reprocessed. Reprocessing requires additional dedicated infrastructures.

The low- and intermediate-level waste (LILW) is produced as a result of operations, such as the cleaning of reactor cooling systems and fuel storage ponds, the decontamination of equipment, filters and metal components, etc. that have become radioactive as a result of their use in or near the reactor.

A 1000 MWe LWR produces about 20 m^3 (27 tonnes) of spent nuclear fuel per year and 200-350 m^3 low- and intermediate-level waste per year. At the moment, there are operational LILW waste disposals in several countries (such as UK, Spain, USA). These disposals are mostly surface or near surface disposals. It can take long time before the radionuclides in HLW has decayed and are not hazardous anymore. Therefore, the wastes must be stored and finally disposed of in a way that provides adequate protection of the public for a very long time. Because of the long-time scale, most countries with high-level and long-lived radioactive waste are investigating deep geological disposal options.

2.3.9 Decommissioning of a nuclear power plant

The life cycle of a nuclear power plant, as of other power plants, can be divided into three periods: construction, operation and decommissioning. The decommissioning phase consists of lowering the radioactivity levels in the plant, disassembling and removing installations and equipment, demolishing buildings upon their decontamination and phasing out of their functions. Decommissioning is composed of the following three stages: final retirement from operations, partial decommissioning and complete rehabilitation of the site.

2.3.10 Principles of nuclear safety

Safety is the central principle when designing a new nuclear power plant to be constructed. Public perception of safety of nuclear facilities is critical to a strong national position. To optimize the safety of nuclear power plants the 'defence in depth' principle is used. This principle is based on an ancient military philosophy of providing multiple barriers of defence. Several simultaneous and independent protection levels need to be applied to the design and use of the power plant (**Figure 2-3: The protection levels in the design and operation of the nuclear power plant following the defence in depth principle).** These can be summed up as Prevention, Monitoring, Action which involves the following: -

- Prevention of operational transients and failures through high-quality design and construction, as well as appropriate maintenance procedures and operation
- Observation of operational transients and failures and returning the situation to normal using protection, control, and safety systems
- Management of design basis accidents using existing and planned safety features
- Observation and management of severe accidents using the accident management system
- Mitigation of the consequences of releasing radioactive substances through emergency and rescue operations.

Nuclear power plants are designed so that the failure of operations at one protection level does not result in any danger to people, the environment or property. In order to guarantee reliability, each of the levels is to be built on several supplementary technical systems, as well as limitations and regulations related to the use of the power plant.

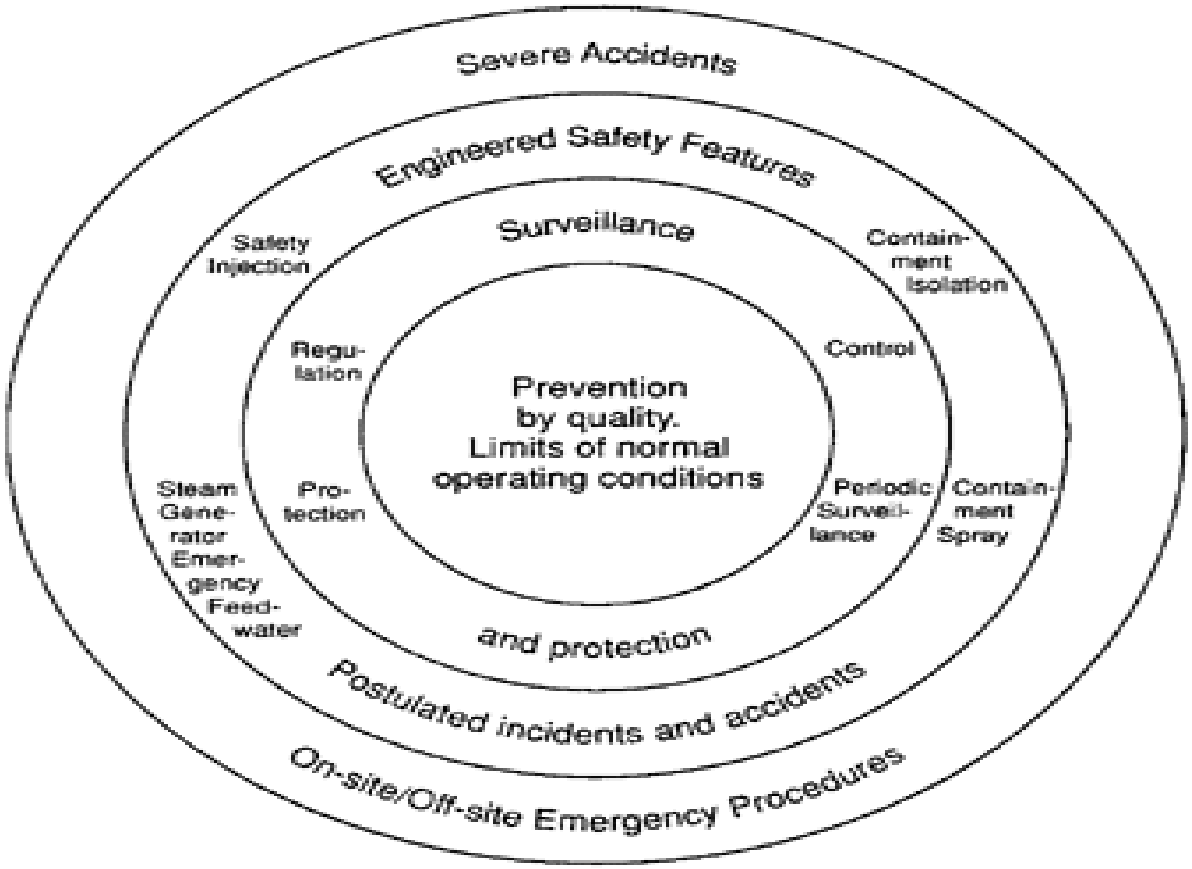

Figure 2-3: The protection levels in the design and operation of the nuclear power plant following the defence in depth principle
Source: Nuclear Energy Agency, 1992

2.4 Site selection for the Nuclear Power Plant

The site selection is an important stage in the nuclear power plant programme. The goal of the siting process is to protect the nuclear power plant against external threats as well as to minimize any social and environmental detriments and threats that might arise from it. The suitability of a site for a nuclear installation should be evaluated with regard to: -

- The effects of external natural or human-induced events occurring in the region of the site. The geomorphological stability of the site should be evaluated as well as the possibility of extreme meteorological/hydrological events.
- In the plant's vicinity, no industrial/military or other activities may be carried out that could pose an external threat to the plant.
- The social and environmental characteristics of the site and its environment that could influence the impact of released radioactive material on humans and the environment. The site should not be located near ecological valuable or vulnerable areas nor densely populated areas.
- The population density and population distribution and other characteristics of the external zone in so far as they may affect the possibility of implementing emergency measures and the need to evaluate the risks to individuals and the population. This means, among other things, that in the plant's vicinity, there may not be facilities or population centres where the necessary protective measures, such as sheltering indoors or evacuation, would be difficult to implement. In principle, the nuclear power plant should be located in a sparsely populated area and far away from large population centres because the emergency

planning is easier to implement on a small group of people. A nuclear power plant site extends to about a kilometre distance from the facility. It is an area where only power plant related activities are allowed. Permanent settlement is prohibited, and only very limited employee accommodation or recreational settlement is allowed.

Other non-safety-related criteria to be considered include availability of cooling water, impact on land use, socio-economic impacts, traffic arrangements, reliable electric power transfer to the national grid and specific factors relating to the security of supply of electric power societal acceptance.

2.5 Site selection for the NPP

The following potential regions were considered during the pre-feasibility studies in site selection: Lake Victoria Basin, the River Tana Basin, the Indian Ocean and Lake Turkana Basin. An in-depth analysis into all the sites has been provided in this report in Chapter Three (3) using the criteria highlighted below.

2.5.1 Hydrology

The three hydrological factors of consideration were flooding, water availability and water quality.

Flooding: The flooding potential and history of the candidate sites was assessed on a general scope. The effects of a probable maximum flood, seiche, surge or seismically induced flood, such as might be caused by dam failures or tsunamis on plant safety functions, can, however, generally be controlled by engineering design or protection of the safety-related structures, systems and components. For some river valleys and flood-prone areas along coastlines, there may not be sufficient information to make the investigations needed to satisfy the criteria for seismically induced flooding.

Water availability: Nuclear reactors require reliable sources of water for steam condensation, service water, emergency core cooling system and other functions. Where water is in short supply, the recirculation of the hot cooling water through cooling towers, artificial pond, or impoundments has been practiced. Adequate and highly dependable system of water supply sources are key for optimal operationalization of the reactor. The adequacy of water supply should also be considered for the entire lifetime of nuclear reactors. The availability of essential water during periods of low flow or low water level is an important initial consideration for identifying potential sites on rivers, small shallow lakes or along coastlines. All the three basins have the potential to supply adequate amount of cooling water.

Water Quality*:* Dispersion and dilution capabilities and potential contamination pathways of the groundwater environment under operating and accident conditions with respect to present and future uses of water sources were put into consideration. Potential radiological and non-radiological of existing contaminants in groundwater should were also considered. The suitability of sites for a specific plant design in areas with a complex hydrogeology or of sites located over aquifers that are or may be used by large populations for domestic or industrial water supplies or for irrigation water can be determined after reliable assessments have been made of the potential impacts of the NPPs on the groundwater quality. For example, Turkana County has the Lotikipi aquifer containing 200 billion cubic meters of fresh water and covers an area of 4,164 km^2. Sites with minimal impact to water quality will be most favourable than a site which gives maximum impact to water quality. Among the three basins, the Indian Ocean has the least impact on water quality followed by Lake Victoria then Lake Turkana.

2.5.2 Geology & Topography

Earthquakes: According to the intensity scale–Peak Ground Acceleration (PGA) classification, the eastern parts of the country have the lowest seismic activities. This includes the entire coastline and the Tana River Basin. The western and parts of the southern areas of the country have the highest ever recorded PGA in Kenya in the last 100 years and they experience frequent medium intensity earthquakes which are either tectonic triggered or volcanic triggered. The nuclear reactor should not be located in areas with potential seismic activity.

Faulting**:** Information on the potential for surface faulting (i.e. the fault capability) for every site was assessed using available geological information. A fault is considered capable if, on the basis of geological, geophysical, geodetic or seismological data (including palaeoseismological and geomorphological data), one or more of the following conditions applies: (a) It shows evidence of past movement or movements (significant deformations and/or dislocations) of a recurring nature within such a period that it is reasonable to infer that further movements at or near the surface could occur; b)In highly active areas, where both earthquake data and geological data consistently reveal short earthquake recurrence intervals, periods of the order of tens of thousands of years may be appropriate for the assessment.

Meteorology

Kenya does not experience extreme weather conditions; neither does it experience significant tsunami effects. The mean annual temperature for the Lower Tana region is 30°C with the highest being 41°C around January-March and the lowest being 20.6°C around June-July. Rainfall is low, bimodal, erratic and conventional in nature. The total annual rainfall ranges between 280 mm and 900 mm with long rains occurring in April and May, short rains in October and November, with November being the wettest month. Based on meteorological considerations, especially in terms of cooling water availability, the coastal region within the lower Tana Basin is therefore the most suitable candidate site.

2.5.3 Biodiversity

All critical habitats and endangered species as well as various environmentally sensitive areas were considered in the SESA. KNPP site avoidance of areas with the likely presence of threatened or endangered species was considered.

2.5.4 Environmental risks

NPP installations are very sensitive establishments that call for assessment and identification of environmental risks within the candidate area that are likely to jeopardize their safety. Flooding was analysed; proximity to intensive mining and vibratory mining activities that may cause tremors were analysed and proximity to aircraft movement with potential for air crash risks were also assessed at a general level. The highest environmental risk is along the Kenyan Coastline and least in the Lake Turkana Basin.

2.5.5 Demographics & society safety

The suitability of NPP sites near existing community clusters should take into consideration the social impacts from the construction, operations, including transmission and transportation corridors for nuclear reactors that will not affect demography, community and individual well-being and the provision of the community infrastructure and social services. The proponent is expected to conduct a comprehensive Social Impact Assessment (SIA) study for preferred site, as a tool to address social implications of the KNPP and to identify adverse social impacts that may arise from construction and operation of nuclear reactors on existing and surrounding communities. The proponent should consult with all the stakeholders and integrated into site evaluation process. The consultation process associated with site evaluation demonstrates involvement of

stakeholders in good faith, openness, respect and fairness with a genuine desire to utilize the input received.

2.5.5.1 Nuclear Safety Security and Safeguards

Nuclear safety and security is geared towards protecting the population against the radiation and the nuclear plant from external threats. Kenya faces a myriad of physical and technical threats that carry a certain level of risk that can compromise national security, energy security, public safety and the national economy, especially terrorism from the al-Shabaab militia based in neighbouring Somalia. All the three basins are not immune to security risks that may be targeted at a nuclear. Nuclear safeguards are applied by IAEA to deter the spread of nuclear weapons by the early detection of the misuse of nuclear material or technology. This provides credible assurances that States are honouring their legal obligations that nuclear material is being used only for peaceful purposes. Kenya has the Nuclear Regulatory Act, 2019 that clear states that all the nuclear material in Kenya shall be used exclusively for peaceful purposes and prohibits manufacturing and application of any use of nuclear weapons or other nuclear related explosive devices.

2.5.5.2 Social Acceptance

Social acceptability is a crucial factor during siting of a nuclear power plant. Setting up a nuclear power plant in any region does not come without concerns and criticism from a wide variety of people. People in such regions fear the threat of being exposed to unusual levels of radiation. As such, a lot of effort has to go into convincing the people living around the plant that it is securely designed with several safety measures. Based on this, all 3 candidate sites face an uphill challenge of convincing local communities to accept the NPP. A comprehensive, financially well-supported and negotiated CSR programme and community social investment programme will have to be put in place.

2.5.6 Electricity grid infrastructure

All the candidate sites are connected to the grid but still generally unreliable. Some of the counties within the sites, especially northern Kenya at times rely on thermal generators for their power such as Samburu, Turkana and Marsabit. The existing grid infrastructure an average range between 132kV to 220kV with plans of upgrade of construction of new higher capacity power transmission lines. Lake Victoria Basin is better connected of the three basins under study.

2.5.7 Transportation Support Infrastructure

Transport support infrastructure is vital for the implementation of the NPP programme. Shipping is the most preferred transport system for reactors due to their weight and nature. The current offshore transport system in Kenya cannot support transportation of the NPP plants reactors and other accessories. This puts the Indian Ocean region at a better front as a preferred candidate site since it meets other parameters thus of minimizing the movements of the nuclear material around the country.

2.6 Transmission Grid and Electricity Generation

2.6.1 Future Electrical Grid Requirements

The national grid in Kenya needs to be improved to suit the introduction of a nuclear power plant. The grid analysis undertaken in the LCPDP 2013-2033 energy forecasts identified gaps that may need to be addressed in order to make the grid more suitable.

2.6.2 Gap Analysis

Conventionally, the largest generating unit in a system should not exceed 10% of the grid capacity. A commercially available nuclear power reactor to be safely operated in the Kenyan system, growth must be achieved in both electricity consumption and non-nuclear power production capacity. Interconnections to neighbouring countries can also provide a bigger base for a large nuclear unit, if they are strong enough with capability of large power flows.

According to "Strategic Plan for a Nuclear Power Programme 2013 in Kenya", a reliable and stable electrical grid with adequate capacity is of fundamental importance for safe operation of a NPP. The grid is expected to undertake two main tasks: i) taking care of the continuous transmission of the produced electricity from power plants to consumers. ii) transmitting off-site power to the nuclear power plant independent of the operational mode of the plant. This is especially important when the plant itself it not producing electricity.

2.6.3 Electricity Generation

Two issues related to generation arise from the current situation. That Kenya's system capacity is too small to support NPP at this stage and the structure of power supply will also need to improve. The system capacity, the structure of power supply and the reserve capacity all have to improve to support nuclear energy.

The grid study was done based on LCPDP 2013-2033 power projections which show that adding the proposed 1,000 MW NPP into the system will require growth in electricity consumption, based on a load demand of between 800 and 1,500 MW. Because commercially available nuclear power reactors of proven design offered today have a capacity ranging mainly between 1000 and 1750 MW, the Grid does not support their construction and connection, if not enlarged.

According to reference capacity fast-tracked/expansion case arising from the committed 5000 MW+ generation in the period until 2018, the additional capacity to be developed will include geothermal 2,095MW, natural gas 1,058MW (including conversions), wind 630MW and coal 1,920MW, thermal 163MW, cogeneration 18MW and imports 400MW. This will improve the status of power supply in the country.

Based on the above proposal, the reserve capacity in the country might not be sufficient for a NPP. The peak demand stood at 1,463MW as at December 2013 against a total effective capacity of 1,684.5MW. This left little reserve margin to allow for reduced hydro generation or any plant breakdowns. In the short term, the Government has contracted an emergency power producer, with a 30MW plant to be installed at Muhoroni, in order to fill the gap. Up to May 2015, the maximum load of the interconnected system in Kenya was 1520MW, while the effective installation capacity of national power system increased to 2203.9MW. The reserve capacity was 702.9MW. The need of reserve capacity will even increase during the coming years because wind power capacity will be increased by more than 630 MW according to plans. Consequently, the wind power sub-sector requires its own reserve capacity, because its power production can vary between 0-100 % of nominal power depending on acute wind condition (typically, wind power produces on average 2000 - 2600 hours/year at nominal capacity).

2.6.4 Electricity Consumption

According to Kenya nuclear power development plan, a 1000MWe plant will be connected to the grid by 2026 and 4000MWe in total by 2030. It is predicted that the power generated from this will mainly be used to fulfil Kenya's demand. Two results of load forecasting were proposed in the grid study. In a high scenario, the peak load in 2026 and 2030 will be 10801MW and 19,940 MW

respectively. Considering the need of not exceeding the 10% of system capacity, the allowable nuclear power installation capacity is 1000MWe and 2000MWe. Relatively, in reference scenario, the peak load in 2026 and 2030 will be 8,531MW and 14,446MW, which means that the allowable nuclear power capacities are 800MWe and 1400MWe.

Options to use interconnections with neighbouring countries can be studied to find out whether their grids can be used in supporting Kenya's capacity increase. If the grid connections are strong enough and have capability of large power flows. If the national grids in Kenya is interconnected with the neighbouring countries to create an integrated network, that might allow connection of a NPP with higher output, even up to 10% of the size of integrated grid. Countries in Eastern and Central African region are jointly pursuing power grid interconnection in order to facilitate power trade in the entire region. The second Kenya-Uganda line has obtained funding while the proposed Ethiopia-Kenya ±500kV HVDC line and Kenya-Tanzania 400kV double circuit interconnection project is under way.

The capability of grid connection between countries should be verified with studies containing a detailed load flow, stability and cost analyses and taking into account realistic possibilities for electricity import and export. In case of use of NPP, political approval might be necessary in both countries, because use of nuclear power might be a sensitive political issue and disturbances in NPP production might affect grids of neighbouring countries by causing disturbances, in worst case black out.

2.6.5 Nuclear Power Integration into the Grid

Some of the prerequisites for interconnection of NPP: Interconnection between power plant and power grid should consider both distance factors and multi-schemes technically and economically within the present and future scenarios. The recommended interconnection scheme should be technically advanced, reasonable, simplified, convenient, flexible, feasible, reliable and economic.

The interconnection of large NPP should prevent severe chain reaction caused by load transfer when severe faults (considering practically possible multiple faults) happen and should avoid transmission capacity concentrating on single line, which might lead to system collapse because of excessive loss of power supply when fault happens.

Environmental and social impacts caused by NPP accidents could be more far-reaching than other power accidents owing to the NPP characteristics. Therefore, in addition to the safe operation of NPP itself, security risks caused by interconnection between NPP and grid should be paid more attention.

2.6.6 Interconnection Scheme of proposed NPP

A comparison between the locations of the proposed NPP systems creates options which have implications on the grid. This can be considered from the option where, two NPPs will be constructed in Kenya, and each will have 2×1000MWe installation capacity. The interconnection between NPPs and power grid will be a combination of 2 arbitrary schemes out of previously proposed 5 schemes (Scheme 1-1~Scheme 1-5). According to Kenya generation expansion plan, a lot of coal-fired power plant will be built in the coast region, using imported coal. By 2030, installation capacity of coal-fired power plant will be 4920MW, most of which is in the coast region. From the demand supply balance results, Nairobi area will still be the biggest electricity consumption market in future.

If two NPPs are all constructed in coast region, the generated power will mainly be delivered to Nairobi via 400kV transmission network. And based on the power grid development plan, by 2030,

Nairobi and Coast will be interconnected by a 400kV Mariakani—Makindu—Isinya double circuits、Lamu Port—Nairobi East double circuits and Lamu Port—Thika double circuits three transmission channels. However, because of long transmission distance (about 500km), the transmission capacity will be restricted seriously by system stability. In addition, it is not economic to deliver power in bulk from Coast to Nairobi as the power loss over long distance is very large.

2.6.7 Grid Code

The Update Grid Code was changed to Reviewed Grid Code in June 2015. This part is utilized to review the KGC. Besides KGC, Kenya National Electricity Transmission Grid Code (KNTGC) and Kenya National Electricity Distribution Code (KNDC) are also collected. It is confirmed that the KGC will entail both the transmission and distribution codes. Therefore, KGC will be the overall grid code that needs to be reviewed to include the component of electricity generated from a nuclear power plant.

Propose a 750kV Interconnection Scheme: Based on previous load flow calculation results, if the NPPs were interconnected to the power system at 400kV voltage level, it is not recommended that all nuclear generation units are constructed in Coast Region. However, in case there is no other site choice and 4×1000MWe NPPs have to be located in Coast Region, it is suggested to deliver the power in bulk from Coast to Nairobi through higher voltage level. As preliminary estimated in the national grid study, it is more suitable to adopt 750kV voltage level for 4000MW power evacuation in 400km or 500km distance.

2.6.8 Offsite Power Supply Plans

NPPs have some similarities to large fossil fuel power plants. The steam turbine, the generator and the large power transformers, including the arrangements for cooling via cooling towers or seawater, are similar. The key difference between NPPs and other power plants is that a nuclear reactor has the potential to cause serious harm to employees and members of the public and cause widespread damage to the environment, if it is not safely controlled. Hence, nuclear safety is the primary consideration at all times in the design and operation of an NPP.

An important characteristic of all nuclear power plants is that after a nuclear reactor is shut down, it continues to produce a significant amount of heat for an extended period. With current designs, the thermal power of the reactor immediately after shutdown is around 6.5% of the power before shutdown, although this reduces to around 1.5% after one hour, and 0.4% after one day. Hence, the reactor cooling systems must continue to operate for several days after a reactor shuts down, to prevent overheating and damage to the reactor core. Therefore, reliable cooling arrangements must be provided, and this requires robust and diverse sources of reliable electrical supply.

The electrical power systems are needed during all modes of operation: start-up; normal operation; during and after reactor shutdown; and as a high priority source of power during certain nuclear events. Special attention must be given during the periods when the reactor is shut down, that the electrical power systems continue to fulfil the applicable safety requirements. Special attention must also be given when parts of the transmission system near to the NPP are taken out of operation for maintenance or surveillance testing.

Because of this reliance on electrical power, nuclear plants are normally required by their operating license to have multiple sources of electricity, including a minimum of two independent offsite power sources (i.e. two connections from the transmission system to the NPP), and onsite power sources (typically a combination of batteries and diesels or small gas turbines).

Based on the operating experience gathered from extreme external events such as hurricanes, tornados, flooding, earthquakes and tsunamis, many NPP operators have taken additional measures to ensure availability of AC power. Some examples of such design improvements are to have hardened structures to house emergency power sources using diesel oil and gas, diverse electrical paths through overhead and underground cables, and connectivity to geographically separate electrical grid networks.

2.6.9 Requirement of NPP for two independent Connections

In order to provide a reliable off-site power source to the NPP's safety systems, general design criteria normally call for at least two independent connections between the nuclear unit and the grid. The first connection is the connection for export of power from the nuclear unit's generator to the main grid via the generator transformer. The second connection provides a supply to the nuclear unit via the station transformer if the first connection is not available. Some nuclear units have more than one station transformer; a few nuclear units have more than one generator, and so have more than one generator transformer.

The connections to the generator transformer(s) and station transformer(s) should be designed in such a manner that one fault cannot render all connections inoperable. One way is to connect the generator and station transformers to separate substations; where this is done the substation for the station transformer could be at a lower voltage than the substation connected to the generator transformer. Alternatively, both the generator transformer and station transformer may be connected to the same substation, but there must be suitable separation between these connections.

A reliable off-site supply also requires a sufficient number of transmission circuit connections from the local substation or substations to the rest of the transmission system, and measures to ensure the substations and transmission circuits are sufficiently robust to withstand extreme events such as hurricanes, tornados, earthquakes or flooding.

2.6.10 Reserve Capacity Scheme

Reserve Capacity is the installation which guarantees that the power system could be in operation with uninterrupted power supply and rated frequency. Generally, reserve capacity includes load reserve, maintenance reserve and emergency reserve.

Load reserve: is the installation which is to fulfil the demand of system instantaneous load fluctuation and unscheduled load increase within a day. The forecasted daily load curve is generally indicated with average hourly load, while the actual load changes instantaneously. The power plant in charge of load reserve is called frequency modulation (FM) power plant. FM power plant usually adopts spinning reserve, because it must be capable of loading immediately.

Maintenance reserve: is the installation which is to fulfil the demand of system maintenance on schedule. In order to ensure safe and economic operation, power generation equipment must have a planned regular maintenance. Normally, maintenance should be arranged in low load period in a year. However, as increase of generation unit capacity and quantity, it is impossible to arrange all maintenance in system low load period, and specific maintenance reserve is necessary. The maintenance reserve margin could be set between 8%~15% of system peak load.

Emergency Reserve is the installation to guarantee normal power supply in case some emergencies happen to generation units in the power system. When some running generation units are compelled to stop due to abnormality or malfunction, emergency reserve is necessary to keep the power system supplying electricity to customers uninterruptedly within specified time.

3 CHAPTER THREE: BASELINE ENVIRONMENT AND SOCIAL SITUATION

3.1 Introduction

This chapter discusses the baseline environmental and social assessment and detailed analysis of the potential and candidate sites. This entailed discussion on the pillars of sustainability including the physical, biological, socio-cultural, socio-economic and infrastructural components in the proposed Nuclear Power Programme.

3.2 The National Environmental and Social Baseline Situation

3.2.1 Biodiversity

3.2.1.1 Flora

In addition to its overall biotic richness, Kenya has a number of distinctive biomes of global significance. They include the East African coastal biome; the coastal forests of Arabuko Sokoke and the lower Tana River; the Afromontane forests of Mt. Kenya, the Aberdares and Mt. Elgon; Kakamega Forest, the eastern-most outlier of the Guinea-Congolian equatorial forests; the Somali-Maasai zone; the expansive afro-tropical grassland and highlands biome; the Victoria Basin biome; and the Sudan and Guinea Savannah biome. These biomes contain high levels of wildlife species diversity and genetic variability, and have many endemic, rare, endangered and threatened species. Yet another distinctive feature of Kenya's biodiversity is the richness and abundance of its terrestrial vertebrates, especially its world-renowned large mammals and their spectacular seasonal migrations.

Underpinning and providing the foundation for Kenya's vertebrate diversity is the richness and abundance of its plant life. A total of 29,614 vascular plant species are known from Africa, including 706 ferns, 44 gymnosperms and 28,864 angiosperms. The East African region has a documented 12,317 species: this is the highest plant diversity per unit area across mainland tropical Africa. Of these at least 7,004 (57 %) are found in Kenya, though this number is likely to change as new species are recorded, existing data is collated and taxonomy changes. For the analysis presented here a total of 4,623 species across 1, 387 genera are available. There are, in addition, 766 species of bryophytes, 511 ferns and 2,071 species of fungi and lichens (Lusweti, 2011).

In describing Kenya's wealth of ecosystems, we highlight the most distinctive ecosystems—the forests, woodlands, shrub lands, grasslands, deserts, wetlands, lakes and rivers, montane, afro-alpine and marine. Using ecosystems-based approach on such recognizable and distinctive habitats and land features draws attention to the ecological functions of the plants and animals, the services they provide, and the uses made of them. Ecosystems are also a convenient way of looking at the threats faced by biodiversity and how to address them. They have the added advantage of applying equally to natural areas as to human landscapes such as cities and croplands.

3.2.1.2 Fauna

Large herbivores and carnivores are the most visible of animals across the Kenyan landscape, with abundance corresponding to rainfall. Kenya possesses a remarkable variety of globally important and valuable animal species. These include birds, mammals, reptiles, amphibians, fish and invertebrates. Kenya has 250 small mammal species distributed in eight orders: *Afrosoricida* (2 spp.), *Macroscelidea* (5 spp.), *Hyracoidea* (4 spp.), *Rodentia* (95 spp.), *Lagomorpha* (3 spp.), *Erinaceomorpha* (1 spp.), *Soricomorpha* (37 spp.) and *Chiroptera* (103 spp).

3.2.1.3 Birds

Kenya has one of the richest avifauna diversities in Africa, with around 1,100 bird species recorded. Of these, 800 species are year-round residents, 60 species are afro-tropical migrants moving within the continent and 170 are Palaearctic migrants that journey from Eurasia each winter. The major migratory flyways in Kenya include the 550km long coastline with its associated creeks, reefs and beaches, and the chain of lakes stretching along the Rift Valley from Turkana in the north to Magadi in the south. Some 170 Palaearctic migrant bird species migrate south to Kenya from Eurasia for the northern hemisphere's winter. Eleven of these species have local breeding populations that are year-round residents. Around 60 species in Kenya migrate only within Africa, including Madagascar (Bennun & Njoroge 1999).

Four globally recognized Endemic Bird Areas (EBAs) are represented in Kenya (Stattersfield et al., 1998). One other EBA, the Jubba and Shebelle valleys, is only marginally represented in Northern-eastern Kenya. EBAs are defined as places where two or more bird species with a world distribution of less than 50 000 km^2 occur together. Kenya has two globally recognized secondary areas of importance-Kakamega and Nandi forests, and the northern Kenya short-grass plains.

3.2.1.4 Reptiles and Amphibians

Kenya has over 220 reptile species, including 100 snakes, 100 lizards, 5 marine turtles, 5 tortoises, 5 terrapins and 1 crocodile. The centre of reptile richness in Kenya runs in an arc of habitats ranging from the coastal forests, though the bushes and grassland savannahs of the Kenya–Tanzania borderlands, and into the Rift Valley. The distribution patterns of snakes and lizards are broadly similar and point to the fact that the cold-blooded vertebrates prefer warmer lower altitudes but all latitudes on a global scale are suitable. Amphibians are associated with wetter habitats and tree frogs mostly with forest and mountain areas. Reptiles and amphibians in Kenya have not received as much taxonomic attention as other vertebrates, so large gaps still occur in specimen collection, mapping and behavioural and ecological studies.

3.2.1.5 Fish

To date, 206 species of fish have been catalogued from Kenyan fresh waters, and a further 18 have been introduced. The distribution of fish in Kenya's drainage systems is determined by the size of the aquatic basin, diversity of aquatic habitats, ability of fish to disperse, temperature, food availability, depth and water movement. Kenya is known for its high endemism of freshwater fishes, totalling 36 in all (Baker et al..,2015).

3.2.1.6 Invertebrates Diversity

Kenya has over 25,000 invertebrates, many of them yet to be described. Insects are the most diverse group of animals. Some of the major species listed for Kenya include 9,000 beetles, 900 butterflies, 500 bees, 650 ants, 60 trips but many of these groups have yet to be recorded or described. Insects include flies, wasps, bees, beetles, bugs, mantis, crickets, grasshoppers, ants, termites, lice, fleas, moths and butterflies. Insects are especially important in the pollination of both wild and cultivated plants ranging from coconuts, mangoes and paw paws to oil palm.

3.2.1.7 Marine Invertebrates

Marine invertebrates cover many phyla ranging from microscopic bacteria and zooplankton to giant molluscs. The more conspicuous and ecologically important phyla include plankton, corals, flatworms, bristle worms, anemones, jellyfish, insects, echinoderms, crustaceans and molluscs. Some 343 species of crustaceans have been recorded in Kenya, including crabs, prawns and lobsters.

3.2.1.8 Areas and species of conservation significance

The gazetted areas and species of conservation significance and their conservation status are respectively documented in the Sixth and the Eleventh Schedules of the Wildlife Management and Conservation Act, 2013. In addition, privately run conservancies and sanctuaries exist. These critical areas may present sensitive receptors of development projects including nuclear power development.

3.3 Climate

Temperatures across Kenya vary with relief, season, rainfall and cloud cover. The northern and eastern lowlands reach maximum average temperatures in excess of 35° C and the central highlands of less than 18° C. Temperatures in the afro-alpine zone of Mt. Kenya drop below freezing every night. Potential evapotranspiration across Kenya varies with rainfall, temperature, altitude and the proximity of water bodies. Evapotranspiration determines the amount of water available for plant growth, whether natural vegetation, farms or forests.

3.3.1 Topography and Geology

Kenya's topography ranges from coastal reefs to high mountains, lake basins, expansive plains and desert. One of the most spectacular features of Kenya is the Great Rift Valley running north south from the Middle East to Mozambique. Other outstanding features include the 5,199m snow-capped summit of Mt. Kenya; the upland massifs of the Mau Escarpment, Cherangani Hills and Aberdare; the Rift Valley lakes of Naivasha, Nakuru and Baringo; the great lakes of Victoria and Turkana; Kakamega, Mau and Arabuko Sokoke forests; the great plains of Amboseli and Samburu; the Chalbi Desert; the coral reefs and mangrove swamps of the coast; and the many wetlands scattered across the lowlands of Kenya

The varied topography (see **Figure 1-1**Figure 3-1 & Figure 3-2 below) and geology of Kenya, modified by hydrology, climate, vegetation, and animal and human impact, creates a diversity of soils that in turn influence the biological properties of ecosystems.

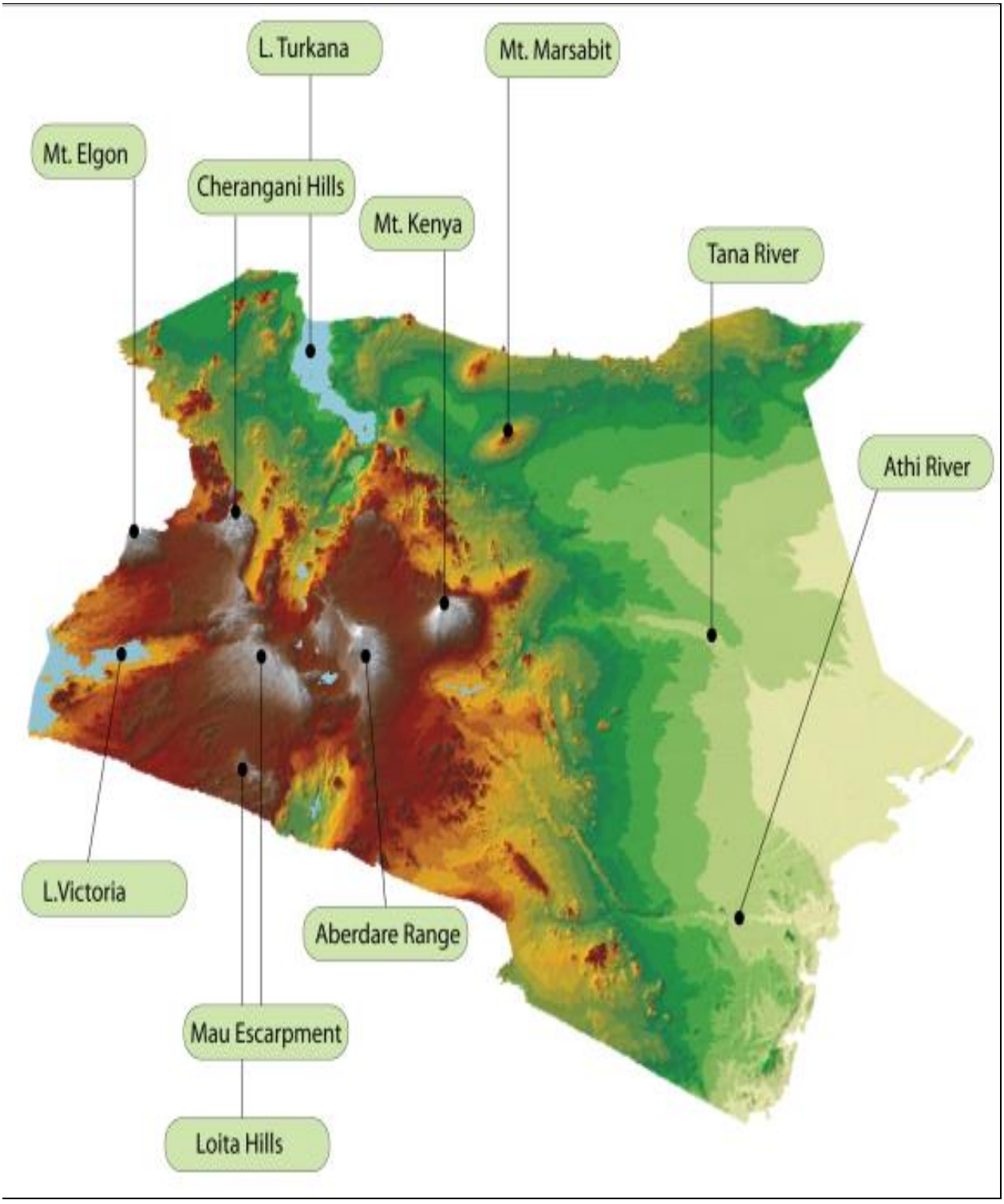

Figure 3-1: Kenyan Topography and hydrogeology
Source: (DRSRS, SRTM/MODIS/NASA)

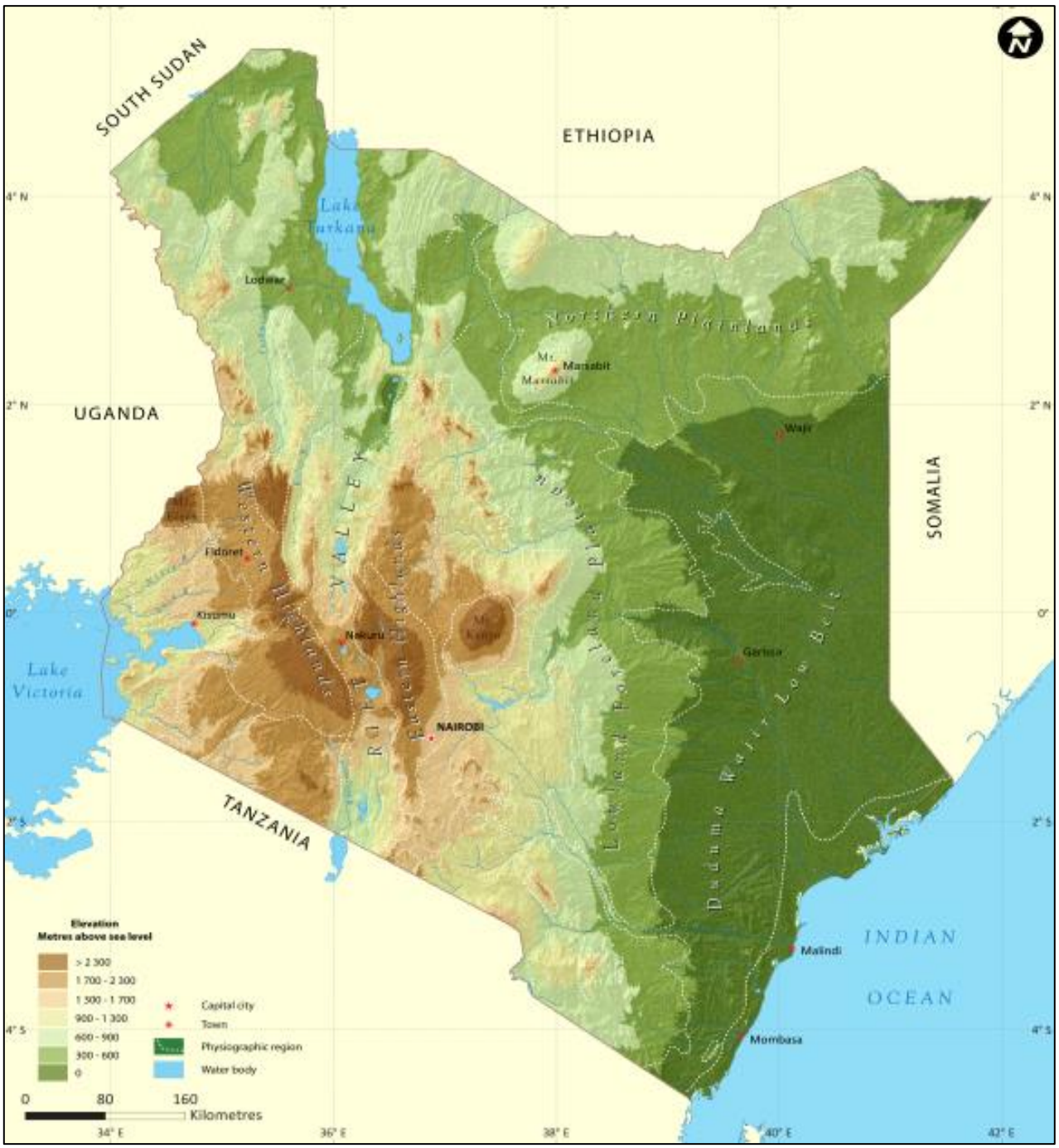

Figure 3-2: Kenya's Landscapes
(Source: DRSRS, SRTM/MODIS/NASA)

3.4 Hydrology

3.4.1 Water, Wetlands and Drainage Basins

Wetlands cover 3 to 4%of the land area of Kenya. The size and composition of wetlands formerly varied with climate, expanding greatly in wet periods and contracting in dry periods. In recent decades, the impact of human activity has played a far larger role than climate. Wetlands have been drained for farming and settlement, waters have been diverted for irrigation, domestic and urban use, and dams built to harness flows and generate hydroelectric power. Wetlands, like

forests, are among the most vulnerable of ecosystems to human transformation due to their freshwater storage capacity. More than any other ecosystem, wetlands are vulnerable to pollution by toxic chemicals, pesticides and fertilizers. In some respects, human activity has created new wetlands, although on a far smaller scale than the natural wetlands lost. So, for example, dams and reservoirs retain large volumes of water that gradually infill with sediments and create local wetlands. The Mwea irrigation rice scheme has created a large, if relatively impoverished, wetland.

3.4.2 Lakes, Dams & Rivers

Freshwater resources, including rivers, lakes and swamps are widely distributed among the main five drainage basins. Major lakes include Victoria, Turkana, Naivasha, Baringo and Nakuru. Many rivers arise and traverse the five drainage basins, amounting to two per cent of Kenya's land area. Average annual water availability per capita is 647m^3, far below the recommended UN threshold of 1 000 m^3/year. DRSRS, WRI et al, 2007.

The diversity of Kenya's water bodies is as great as the terrestrial habitats and should rightly be considered as several ecosystems. So, for example, lakes range from the large freshwater inland sea of L. Victoria to the brackish L. Turkana and extremely saline lakes, Nakuru and Magadi. Highland streams are small, cold, clear and fast flowing with relatively low organic suspended organic matter, whereas the lower Tana and Galana rivers are large, warm, and sluggish and are rich in suspended organic matter. Alkalinity, salinity and chemical composition also affect the properties of lakes and rivers, and thus the abundance and composition of plants and animals.

3.5 Population

Kenya's population grew from about eight million people in 1960 to 10.9 million in 1969, 15.3 million 1979, 21.4 million in 1989, 28.7 million in 1999 and 38.6 million in 2009. The population now stands at 40 million, a fourfold increase from 50 years ago, with growth continuing at 2.9 per cent per year. Present projections put the population at 51 million by 2025 and 96.9 million by 2050 (UNDP, 2014). **Figure 3-3** shows the population density patterns in Kenya.

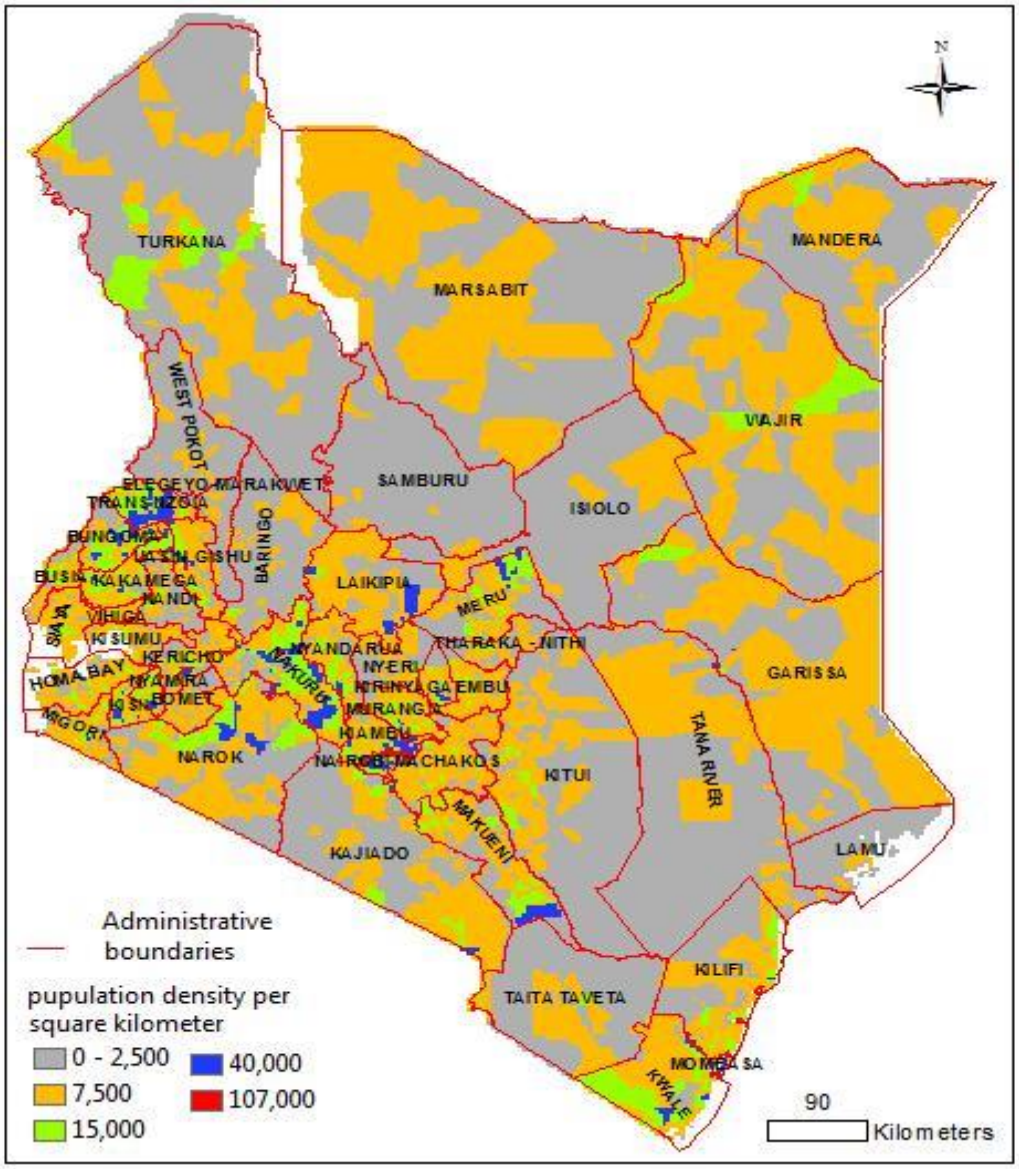

Figure 3-3: Population density in Kenya (Source: Onjira 2014)

3.6 Cultural Heritage & Livelihood Systems

Kenya's cultural history is the product of a varied array of some 45 ethnic groups. Each culture has a unique heritage and livelihood sustained by the land and its natural resources. The term 'culture' has many definitions, but in the context of human history, it refers to a system of behaviours, symbols and ways of relating to each other that allows people to live in social groups and meet their needs. Over centuries, farmers and herdsmen experimented with crops and livestock, eventually developing husbandry practices, cultivars and breeds that allowed them to survive and prosper across the varied landscapes of Kenya.

In heavily forested areas, where ruminants fare poorly, bees substituted as 'livestock' among hunting and gathering as well as farming communities. Hunter-gatherers acquired knowledge about the animals they hunted and the food they gathered. Kenya had many different groups of hunters-gatherers in highland forests as well as coastal lowlands. Today they include the Sengwer, the Ogiek, the Yaaku, the Sanye and Aweer, among others. Each invested in worked traps, weapons and beehives, and stored food such as dried meat and honey for lean times.

For the last 3 000 years, Kenya's rangelands have been occupied by herders who use fire to create grasslands and fresh grazing land, and to control parasites. The pastoral way of life reshaped the savannahs and largely supplanted hunter-gatherers. The human imprint of traditional peoples transformed Kenya's landscape and ecology but caused few animal or plant extinctions. One reason is the mobility of subsistence farmers and herders. Pastoralists varied their herd composition to adapt to wet and dry periods, achieving higher production and better resilience to droughts. Many communities still practice pastoralism, including the Maasai, Samburu, Turkana, Borana, Burji, Gabbra, Rendille/Ariaal, Somali, Pokot, Wardei and Orma. Agriculturalists such as the Kikuyu, Meru, Embu, Pokomo, Kamba, Taita, Tharaka, Kisii, Kipsigis, Luo, Nandi, Teso and Luhya lived in high- or mixed potential zones, which sustained crops. Pastoralists and agriculturalists have different concepts of land 'ownership' and user rights, which shape their governance of land and natural resources.

A number of communities in Kenya practice fishing, either as their major livelihood, or as a supplement to pastoralism and agriculture. Important coastal and lakeside fishing communities include the Bajuni, Somali, Mijikenda, Arabs, Kauma, Luo, Luhya, Suba, Turkana and El Molo. Because of infertile soils, Kenya's coast has low arable potential despite its rainfall. As a result, coastal people supplement farming with other livelihoods, including fishing and trading, linked to the monsoon winds. Over centuries, the coastal communities acquired a deep knowledge of the winds, tides and seasons, and developed productive and adaptable fishing customs.

During the 20th century, traditional artisanal practices gave way to mechanized and commercial fishing, as a result the increased exploitation and impact on ecosystems has depressed fish stocks, cleared mangrove forests and damaged reefs. More farmers are supplementing their income with fishing, putting pressure on stocks and depriving traditional fishing communities (McClanahan *et al*., 1997; Versleijen & Hoorweg 2008; Fulanda *et al*., 2009). Kenya's lake communities also have a long history of fishing, often supplementing to agro-pastoralism and hunting practices.

3.7 Regional Environmental and Social Baseline Situation

3.7.1 Lake Victoria Basin

3.7.1.1 Introduction

The Lake Victoria Basin (LVB) covers 250,000 km^2, with Tanzania occupying 44%% Kenya 22%%, Uganda 16%%, Rwanda 11%%, and Burundi 7%% of the land area (See **Figure 3-4** below). Agriculture and livestock, fisheries, wildlife and tourism and mining are the major sources of income in the LVB. Comprising significant areas of savannah, forests, mountain highlands, and wetlands, the LVB contains an extremely rich, unique, and wide range of aquatic and terrestrial species. Its biologically significant areas include over 100 globally or regionally recognized, significant ecosystems, including Maasai Mara–Serengeti, Mount Elgon, Nabugabo RAMSAR Site in Uganda, and the Nyungwe–Kibira trans-boundary landscape.

In Kenya, the Lake Victoria Basin (LVB) covers the entire Nyanza and Western regions and drains extensive sections of the eastern slopes of the Rift Valley, an area that extends from Cherangani Hills to the Mau Forest, including the Maasai Mara Game Reserve in the Rift Valley Province. The LVB is comprised of two basins i.e. Lake Victoria North Catchment Area (LVNCA) and Lake Victoria South Catchment Area (LVSCA) respectively. However, for the purpose of the NPP, the main focus of this chapter will be on the LVSCA with attention being on the following counties of interest within the LVB: Siaya, Kisumu, Homa Bay and Migori Counties**.**

Figure 3-4: Map of Lake Victoria Basin
(Adopted from Koyombo and Jorgensen, 2006)

Table 3-1: **Environmental and Social Baseline Situation of Lake Victoria Basin Counties**

Parameters	Siaya County	Kisumu County	Homa bay County	Migori County
Hydrology	-River Nzoia and River Yala -Yala Swamp (3rd largest in Kenya)	-Rivers Nyando, Kidos and Sondu flowing into Winam Gulf -Kano Plains vulnerable to flooding	-Awach Kibuon, Awach Tende, Maugo, Kuja, Rangwe and Riana rivers originating from Kisii and Nyamira Counties. -Islands and the coast of Lake Victoria and the peninsula like Sikri of Mbita	-Rivers Kuja, Migori and Riana - Other small rivers are Ongoche, Oyani and Sare - Gogo Falls found in River Kuja
Geology and Topography	-3 major geomorphologic zones: dissected uplands, moderate lowlands and Yala Swamp. -Altitude from 1,140m on the shores of Lake Victoria to 1,400m above sea level on the North. -Hills include Mbaga, Odiado, Akala, Regea, Nyambare, Usenge, Ramogi hills, Rambugu, Abiero, Sirafuongo and Naya hills. - Rocks include basalts, desites and rylites - Soil types are ferrasols, black-cotton, sandy loams to laterite including red volcanic soils	-3 topographical zones: the Kano Plains, the upland area of Nyabondo Plateau & the midland areas of Maseno. - With an altitude of 1,835m above sea level. - Soils are dominated by lake sediments, commonly sand and clay soils - dark cotton soils commonly associated with the swamps constituting more than 70% of all soil types in the County. -The altitude varies from 1,144 metres above the sea level on the plains to 1,525 metres above sea levelin Maseno and Lower Nyakach areas	-2 main relief regions; lakeshore lowlands and the upland plateau - The lakeshore lowlands lie between 1,163 – 1,219 metres in upper plateau above the level - residual highlands such as Gwassi and Ngorome hills in Suba, Gembe and Ruri Hills in Mbita, Wire Hills in Kasipul, Homa hills in Karachuonyo. Kodera forest in Kasipul and the Kanyamwa escarpment - to the west of the county lies the Lambwe Valley where Ruma National park is located	- Undulating hills covers most of the county with a few stretches of flat land. - The county has an altitude varying between 1140m at the shores of Lake Victoria in Nyatike Sub County to 4625m in Uriri Sub-county. - Most parts of the county are covered by underlain by relatively acidic parent rock. - Granite covers most parts of Kuria East, Kuria West, Nyatike, some parts of Rongo and Migori Sub-counties
Meteorology	- Experiences bi-modal rainfall, with long rains falling between March and June and short rains between September and December - Rainfall ranges between 800mm 2,000mm. -Temperatures vary between 21° C to about 22.50° C. Humidity relatively high with	- 2 rainy seasons, with the long rains occurring in March and May while the short rains occur in September to November. -the short rains annual average rainfall ranges between 450mm and 600mm. - The lowland area which forms a trough of low rainfall receives a mean annual rainfall of	- 2 rainy seasons namely the long rainy season from March to June and the short rainy season from August to November. - county receives an annual rainfall ranging from 700 to 800 mm. - Temperatures in the county ranges from 18.6°C to 17.1°C	- Annual rainfall averages between 700- and 1,800-mm. Long rains are between March and May while the short rains are between September and November - Temperatures show mean minimum of 24^0C and maximum of 31^0C,

Parameters	Siaya County	Kisumu County	Homa bay County	Migori County
	mean evaporation being between 1,800mm to 2,200mm per annum	between 1,000mm and 1,800mm. - mean annual maximum temperature ranges 25^{o}C to 35^{o}C and the mean annual minimum temperature ranges 9^{o}C to 18^{o}C		with high humidity and a potential evaporation of 1800 to 2000 mm per year
Biodiversity	-Yala Swamp is the richest ecosystem in biodiversity and is home to fish species, a number of macrophytes, swamp grasses, a rich community of invertebrates and birds. The aquatic nymphs of mayflies' dragonflies*)* and stoneflies - Other species of wildlife found in the County include hippopotamus, crocodiles Sitatunga monkeys, and leopards.	- The main wildlife include silver backed jackals, leopards, baboons, ostriches, hyena, guinea fowls, duikers, lion, impalas, vervet monkeys, bird species, sitatungas, crocodiles, pythons, monitor lizards, hippos, among others. ---- Dunga Beach is an IBA and home to threatened Papyrus Yellow Warbler	- The main wildlife found include Topi antelope, hyenas, Roan antelopes, giraffes, buffaloes, hippopotamus, crocodiles and various species of snakes. - Lately, zebra and rhinoceros have been introduced to Ruma National Par	Various animals have been identified such as gazelles, monkeys, snakes, leopards and hyenas. - In the Lake Victoria, there is presence of wild animals such as the hippopotamus and variety of birds. - birdlife in Migori is varied with many records of blue flycatcher, blue-spotted wood dove, harrier hawk, bat hawk, baglafecht weaver, tawny eagle, purple grenadier, beautiful sunbird, yellow-billed stork, hadada ibis, African citril, cape turtle dove, paradise flycatcher, yellow white eye, white-browed robin chat, black-headed gonolek, black kite among others
Environmental Challenges & Risks	-Flooding and Droughts - Invasive species	-Solid and liquid waste*:* -Sand harvesting*:* -Invasive species - water hyacinth	-Deforestation -Solid waste Management -Climate change	-Desertification -Flooding:

Parameters	Siaya County	Kisumu County	Homa bay County	Migori County
Demographics	- Total population as at 2012 was estimated to be 885,762 persons 419,227 males and 466,535 females (KNBS 2012 Population projections). -- population is expected to grow at a rate of 1.7 per cent per year	-the 2009 Population and Housing Census was estimated at 968,909 persons with 474,687 males and 494,222 females	- the 2009 Kenya Population and Housing Census, Homa bay County has an estimated population of 1,038,858 persons consisting of 498,472 males and 540,386 females by the end of the year 2012	- the 2009 population census was 917,170 comprising of 444,357 males (48.6%) and 472,814 females (51.4%).
Electricity grid infrastructure	- connected to the grid and plans are underway to connect it establish two substations in Siaya county in Bondo and Ndigwa, Rarieda Sub County	- connected to the grid, but a number of projects are underway to ensure power reliability for economic development	- all urban centres and most trading centres in the county have now been covered under the rural electrification programme	- Urban centres in the County are all connected to the grid with a number of schools also connected via the rural electrification programme
Transport support infrastructure	-283.2 Km of bitumen standard roads, 741.3Km of gravel and 1,161.8 Km of earth roads as at December 2012 - 3 airstrips in the County namely: Gombe, Dominion and Sega	- 671 km of class A and B roads; and class C, D, E and R roads across the County. - County hosts the third busiest airport in Kenya and the Country's fourth International airport	- 1 class A1 (Kisii-Kisumu) road about 30 km. -1 class C20 (Homa Bay – Rongo) road covering - 30 Km. - 2 class C19 (Homa Bay – Mbita and Homa Bay – Kendu Bay) - about 71 Km -1 class C18 (Rodi Kopany – Sori) road - 32 Km. -168 Km of the road surface in the county is under bitumen - County has 5 airstrips	- traversed by 104.6 km of tarmacked road including Road A1 that links Kenya with Tanzania through Isebania - 3 airstrips, - Water transport is still at its infancy stage

3.7.2 The Lake Turkana Region

3.7.2.1 Introduction

Lake Turkana is the largest and most saline of the Rift Valley lakes. With current faulting experienced on the floor of the rift valley, Lakes Bogoria, Naivasha and Nakuru were left out due to instability risk at the rift valley. Lake Turkana has no outlet, and with reduced inflows and high evaporation, this results into depositing of salt in the soil and capping on the surface. The water level is subject to three to four metres seasonal fluctuations. In total, the water level dropped 10m between 1975 and 1992. River Omo from Ethiopia, which is permanent, drains into Lake Turkana as indicated in **Figure 3-5** below.

The lake is an important site for water birds with up to 220,000 congregants having been recorded at one time and 84 water bird species, including 34 Palearctic migrants, known from the lake (Bennun & Njoroge 1999). Over 100,000 *Calidris minuta* have been recorded at the lake, in addition to smaller congregations of other non-breeding water birds (*Pelecanus rufescens*, *Phoenicopterus ruber*, *Vanellus spinosus*, *Charadrius hiaticula*, *C. asiaticus*, *C. pecuarius*) (Bennun & Njoroge 1999). Bird species present near Lake Abaya include *Anhinga rufa, Bubulcus ibis, Casmerodius albus, Egretta garzetta*, *Haliaeetus vocifer*, and *Scotopelia peli* (Hughes & Hughes 1992). Other aquatic animals in the eco-region include *Hippopotamus amphibius, Crocodylus* spp., and an endemic freshwater turtle, the recently discovered and imperilled Turkana mud turtle (*Pelusios broadleyi*) (Hughes & Hughes 1992; Expert Center for Taxonomic Identification 2000).

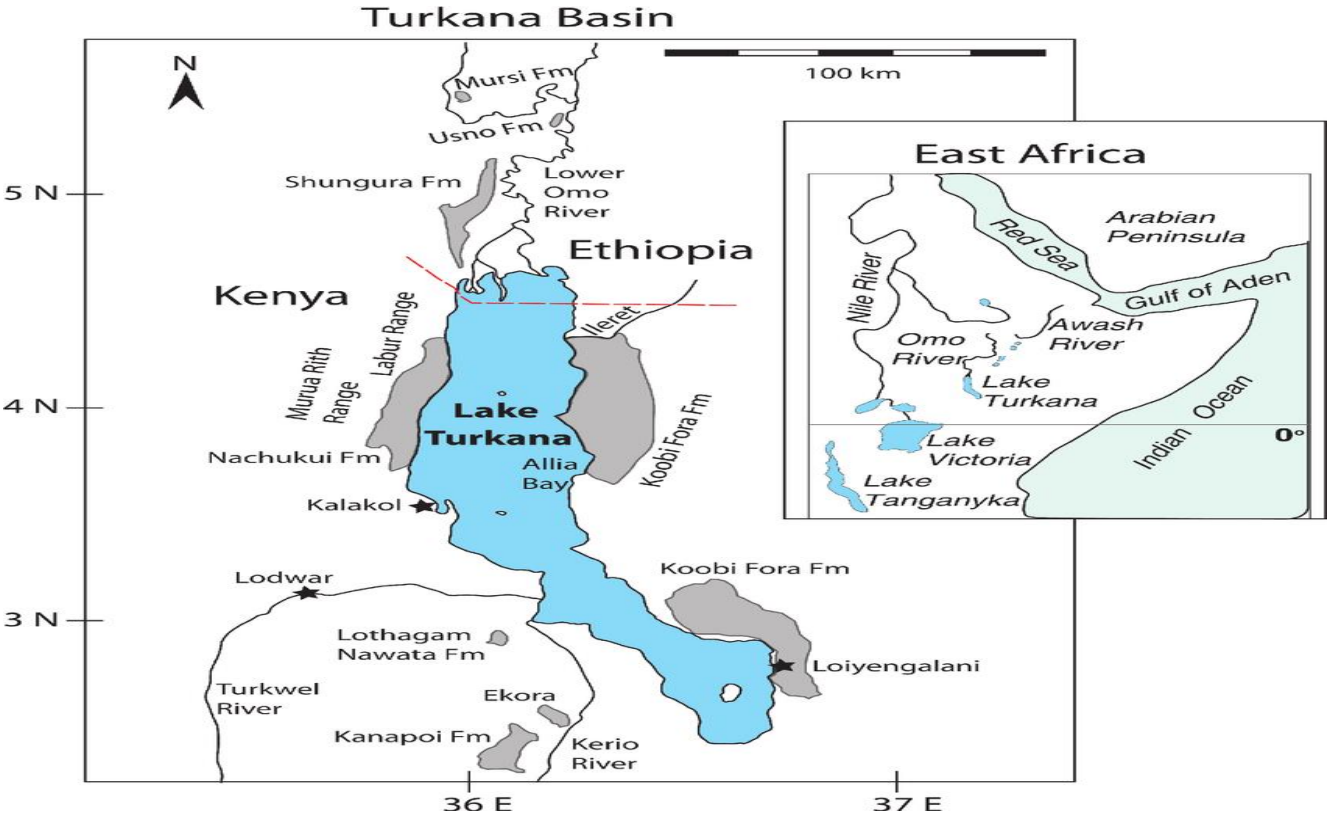

Figure 3-5: The Lake Turkana Basin
Source: Bobe et al. (2009)

Table 3-2: Environmental and Social Baseline of Lake Turkana Regions

Parameters	Turkana County	Marsabit County	Samburu County
Hydrology	- Rivers Tarach, Kerio, Kalapata, Malimalite and Turkwel - underground water aquifers at Loitipis and Lodwar basin	- no permanent river, but has four drainage systems, covering an area of 948 sq. km - Chalbi Desert is the largest and receives run-off from the surrounding lava and basement surfaces of Mt. Marsabit, Hurri Hills, Mt. Kulal and the Ethiopian plateau. - the seasonal rivers of Milgis and Merille flow and drain into the Sori Adio swamp. - Other drainage systems include the Dida Galgallu	- drainage areas number two (Kerio Valley) and number five (Ewaso Nyiro). - Main water sources in the county constitute of surface and ground water. - Ewaso Ng'iro River - several seasonal riverbeds or "laggas"
Geology and Topography	- Lake Turkana is at an elevation of 360 m while the surrounding basin is anywhere from 375-914 m - open lying plains consist of the Kalapata and Lotikipi Plains. - lowest amount of rainfall of around 180 mm per annum. -Soils in Turkana County are not well developed due to aridity and constant erosion by water and wind.	- extensive plain lying between 300m and 900m above sea level -plain is bordered by hills and mountain ranges and is broken by volcanic cones and calderas to the west and north of the county - Chalbi Desert, an area of 948 sq. km, lie between 435m and 500m elevation -	- falls on the northern interface between highlands and lowlands - Characterized by repeated extensive high-level plateaus which have been built by repeated floods of lava from the Rift valley. - The highest parts of these plateaus are the Kirisia Hill, rising to 2000m above sea level -In the western parts of the county, the soil is mostly Sandy loam soils. - the predominant soil in the northern part of the County consisting of Baragoi and Nyiro areas are bouldery cambisols and lithosol.
Meteorology	- arid and semi-arid and is characterized by warm and hot climate. - The temperatures range between 20ºC and 41ºC with a mean of 30.5ºC. - two rainfall seasons. - long rains usually occur between April and July and the short rains between October and November and ranges between 52 mm and 480 mm annually with a mean of 200 mm -	- temperature ranges from a low of 15^0C to a high of 26ºC, with an annual average of 20.5^0C - bi-modal rainfall pattern - long rains occur between April and July - short rains between October and November - ranges between 52 mm and 480 mm annually with a mean of 200 mm. - surface runoff and potential evaporation rates are extremely high -	- Lorroki Plateau receives between 500 mm and 700 mm of rain annually. The Nyiro and Ndoto Mountains and Matthews range receive the highest amount of rainfall between 750 mm and 1250 mm per annum. The central basin and the plains east of the Matthews Range are the driest parts of the county with annual rainfall of between 250 mm and 500mm. Annually, the county has annual mean temperature of 29^0c with the maximum range being 33^0c and minimum of 24^0 -

Parameters	Turkana County	Marsabit County	Samburu County
Biodiversity	- elephants, leopards, oryx antelopes, gazelles, warthogs, high number of Kori bustard roam - the Central Island National Parks all within the Lake Turkana basin designated as a UNESCO World Heritage Site	- Zebras, buffaloes, black and white colobus, blue monkeys, bushbucks, sunis, and leopards populate the park. - more than 350 species of birds in total, of which 52 are birds of prey e.g Ruppell's griffon vultures, peregrine falcons, mountain buzzards, black kites and African fish eagles; sociable weaver birds, - elephants, reptiles and variety of butterflies also exist within the County	- the largest number of wildlife outside protected area systems in Kenya. -Some of the wild animals include lions, cheetahs, leopards, giraffes, buffalos, waterbucks and various antelope species. - endangered species include Grevy's zebra, wild dog's, African elephants and black rhino, birds and different species of small wild game. - Samburu Special five species of wildlife which are endemic to Samburu and a few other areas north of the equator. - including Reticulated giraffe, Beisa Oryx, Grevys Zebra, Gerenuk and Somali Ostrich. - rare and endangered species such as Debrazza monkeys in the Ndoto and Matthews forests. -hundreds of bird species.
Environmental Challenges & Risks	-Charcoal production -Waste disposal -Riparian Farming -Climate Change -Faulting -Seismicity and Seismic Hazard	- Environmental degradation in the county is mainly as a result of deforestation and forest encroachment due to dependence on firewood and overgrazing.	-Land Degradation - Destruction of forests - Invasive species - poor disposal - Climate Change
Demographics	- population stood at 926,976 in 2019 according to the Kenya Population and Housing census. - 60 % of the population is young under the age of 19 years - low literacy levels estimated to be about 40% in the county	-459,785 people in 2019 according to the Kenya Population and Housing census. -This population is projected to rise to over 727,000 in 2050	- the 2019 Population and Housing Census, the population of Samburu County was 310,327. -Given a population growth rate of 4.45 % per annum the County population is projected to increase to 456,418 by 2025
Electricity grid infrastructure	- connected to the grid though not entirely - relies on thermal power productions. -Plans are underway to connect the county through Turkwel- Loki char – Lodwar 220kV Electricity Transmission Line	- few parts of the county are connected to the national grid. - Moyale and Sololo are connected with electricity from Ethiopia. - KETRACO plans to construct a 150km 400kV Electricity Transmission Line from Loiyang'alani to Marsabit	- County is connected to the grid but also dependent on Thermal power production. - Plans are underway by KETRACO to connect the County to Nyahururu, Rumuruti and Isiolo with a substation at Maralal.

Parameters	Turkana County	Marsabit County	Samburu County
Transport support infrastructure	- total road network of 5,496.2 km of which 488.5 km are bitumen, and 5007.7 km earth surface. - one airport in Lokichoggio and 22 airstrips	- road network in the county is approximately 5,000 km. - comprises of 312 km tarmacked, 580 km gravel surface and 4,108 km earth surface. - 18 airstrips located in all sub-counties. - All the airstrips are in good condition and currently in use	- total road network length is 1,606.6 kilometres, -Tarmac road (probase) covers a length of 10 kms, -improved (graveled) road covers a length of 1,081 km - new roads cover 515. 6km. - 11 airstrips in Samburu County

3.7.3 The Coast Region

3.7.3.1 Introduction

The coastal region covers 79,686 km², (See **Figure 3-6** below). Agriculture and livestock, fisheries, wildlife and tourism and mining are the major sources of income in the region. Comprising significant areas of forests, marine reserves, and wetlands, the LVB contains an extremely rich, unique, and wide range of aquatic and terrestrial species. Its biologically significant areas include over 100 globally or regionally recognized, significant ecosystems, including Dodori and Boni National Reserves, Kiunga, Mombasa, Malindi, Watamu, Diani Chale and Mpunguti Marine National Reserves.

In Kenya, the Coastal Region covers the entire Kenyan coastline and drains extensive sections of the eastern slopes of the Central Kenya, an area that extends from Mt. Kenya to Eastern Province. The Coastal region is comprised of two basins i.e. the Athi River Basin and the Tana River Basin. However, for the purpose of the NPP, the main focus of this chapter will be on the Coastal region with attention being on the following counties of interest: Lamu, Tana River, Kilifi, Mombasa and Kwale.

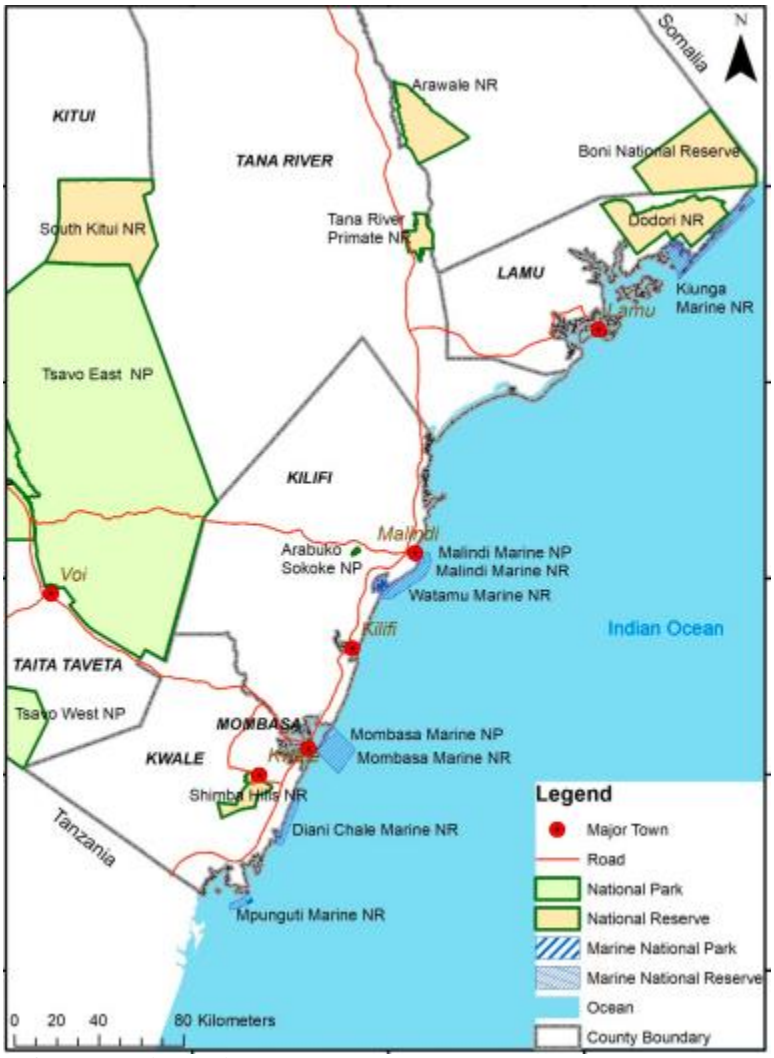

Figure 3-7: Map of Coastal Region (Source: Kenya Wildlife Service)

Table 3-3: Environmental and Social Baseline Situation of the Coast Region Counties

Parameters	Lamu County	Tana River County	Kilifi County	Mombasa County	Kwale County
Hydrology	-4 catchment areas - Dodori coastal zone, Duldul, Lamu bay drainage and Tana River Delta	-River Tana traverses the county from the Aberdares in the North to the Indian Ocean in the South - approximately 500km. - are several seasonal rivers in the county popularly known as lagas	- permanent river (Sabaki - seasonal rivers are Nzovuni, Rare, Goshi and Kombeni. - streams include Wimbi, Muhomkulu and Mleji	- semi-perennial rivers and streams. - These rivers are Kombeni and Tsalu that drain into the Indian Ocean.	- drained by 7 major rivers and numerous minor streams. Of the seven (7) rivers, three (3) are Permanent - The main rivers and streams are Ramisi, Marere, Pemba, Mkurumuji, Umba, Mwachema and the Mwachi River
Geology and Topography	- generally flat and lies between altitude zero and 50m above sea level. - main topographical features include coastal Island and Dudol plains, sand dunes and the Indian Ocean	- major physical features is an undulating plain that is interrupted in a few places by low hills at Bilibil -	- 4 major topographical features -Coastal belt - lies below 30m above sea level with a few prominent peaks. Has several creeks resulting in excellent marine swamps endowed with mangrove forests and present potential for marine culture -Foot plateau - plateau falls between 60m and 150m altitude and slopes towards the sea - Coastal range falls beyond the foot plateau and has distinct low range of sandstone hills and ranges between 150m to 450m high. These hills include Simba, Kiwava, Daka, Wacha, Gaabo, Jibana, Mazeras and Mwangea. - Nyika plateau that rises from 100m to	- 3 distinct physiographic features, which include the coastal plain. Coastal lowland which rises gradually from the sea level in the East to about 132m above sea level in the mainland - second category is the hilly areas mainly found within the Western part of the County that is underlain by shells and rises gently from 45m to 132m above sea level - third category is the Indian Ocean and the shoreline covered with geologically sedimentary rocks of Jurassic to recent age. - Nyika Plateau, also referred to as the hinterland, rises	- 4 major topographic features namely the Coastal Plain, the Foot Plateau, the Coastal Uplands and the Nyika Plateau. - Coastline is about 250 kilometres - Foot Plateau, which is behind the Coastal Plain, lies at an altitude of between 60 and 135 meters above sea level - Coastal Uplands, commonly known as Shimba Hills rise steeply from the foot plateau at an altitude of between 135 to 462 meters above the sea level. - Nyika Plateau, also referred to as the hinterland, rises gradually from about 180 meters on the western boundary of the county -

Parameters	Lamu County	Tana River County	Kilifi County	Mombasa County	Kwale County
			340m above sea level and occupies about two thirds of the county area covers the lower lying ground along the western side of the county.	gradually from about 180 meters on the western boundary of the county	
Meteorology	- 2 rainy seasons and temperatures ranging between 23^0 and 32^0C	-hot and dry climate within ecological zones ranging from III to VII -Average annual temperatures are about 30^0C -Rainfall is low, bimodal, erratic and conventional in nature. -The total annual rainfall ranges between 280 mm and 900 mm with long rains occurring in April and May, short rains in October and November with November being the wettest month	- average annual rainfall ranges from 300mm in the hinterland to 1,300mm at the coastal belt. - annual temperature ranges between 21^o C and 30^oC in the coastal belt and between 30^oC and 34^oC in the hinterland	- 2 distinct long and short seasons. The long rains occur in April – June with an average of 1,040 mm. The short rains start towards the end of October lasting until December averaging 240mm. -The annual average rainfall for the county is 640mm - annual mean temperature in the county is 27.9^0C with a minimum of 22.7^0C and a maximum of 33.1^0C.	-. Rainfall is bimodal with short rains being experienced from October to December, while the long rains are experienced from March/April to July. -The total annual precipitation varies from 900mm– 1500mm per annum along the coast to 500mm to 600mm per annum in the hinterland. - The average annual rainfall ranges from 600mm in the hinterland to 1200mm at the coastal belt. -Average temperature ranges from 26.3^0C to 26.6^0C in the coastal lowlands, 25^0C to 26.6^0C in Shimba Hills, and 24.6^0C to 27.5^0C in the hinterland
Biodiversity	- Forests cover 11.5% of total county land surface area - 3 national reserves, 2 national parks and 3 private ranches which are home to several species of wild animals.	- dominated by complex ecosystem of high canopy coastal, riverine forests, wooded bush land and thickets as well as the grasslands and mangrove forests covering 355,688.65 ha. - listed as a Ramsar site; UNESCO	-Wildlife is mainly found in the Arabuko Sokoke Forest Reserve, Malindi Marine Park and Watamu Marini Reserve. -In Arabuko Sokoke Forest Reserve, there are 240 bird's species, 261 butterflies, 79 amphibians, 52	- has natural forest of approximately 300 ha and 138 acres of agroforestry - home to mangrove forests, protected by KFS, and several indigenous trees. - Wildlife majorly found in the Marine	- total area covered by forests is about 7 per cent, 54,544 hectares (35,043 hectares gazetted, and 19,500 hectares not gazetted). - gazetted for conservation as the Shimba Hills National Reserve and the Mwaluganje Elephant Sanctuary.

Parameters	Lamu County	Tana River County	Kilifi County	Mombasa County	Kwale County
		tentative site of cultural and natural heritage and a listed International Bird Area (IBA). - stronghold for 2 Near Threatened, restricted-range species, *Anthus melindae* and *Acrocep halus griseldis* (probably its main wintering ground). - supports one of the very few breeding sites for colonial water birds in Kenya. -floodplain is grazed by a number of ungulates, -The rivers and channels support large numbers of hippos and crocodiles-Ungwana Bay is one of the few places where *Dugong dugon* critically endangered in the region - 22 freshwater fish species are recorded from the lower Tana -mangroves also found within the delta - At least 280 plant taxa are recorded for the delta	mammals and 600 plants species. - These mammals are also endangered species: Aders Duiker, Sokoke Bush Tailed Mongoose, and Golden rumped elephant shrew. -The Malindi Marine Park is endowed with resources such as fringing reefs, coral gardens in the lagoons, sea grass beds, mangroves, mudflats, and high fish diversity, marine mammals (e.g. dolphins), turtles and various species of shorebirds. - Watamu Marine Reserve, habitats include intertidal rock, sand and mud, fringing reefs and coral gardens, coral cliffs, sandy beaches and the Mida Creek mangrove forest. -Marine life include fish, turtles, dugongs and crabs. - Mida Creek forest has a high diversity of mangrove species	ecosystem, natural terrestrial habitats and the in the private sanctuaries. - Buffaloes, wildebeests, giraffes, hippopotamus, tortoise, birds and butterflies are some of the wildlife in the County. - Marine parks are home to a colourful variety of marine species including crabs, starfish, stone fish, cucumbers sea urchins, corals, turtles, sea grasses and interesting migratory birds including crab plovers	-animal species found in the reserves are elephant, eland, sable antelope, giraffe, yellow baboon, Angolan columbus, sakes monkey, Grimm's bush buck, hyena, leopard, buffalo, and water back. -The sable antelope has been gazetted as endemic. -The County has also recorded 111 forests birds' species of which 20 are coastal birds. - mangrove forests and sea grass beds perform vital functions in protection and enrichment of the coast eco-system. - serve as habitat for many species of fish octopi and holothurians that are exploited commercially. -Mangrove forests are habitat for a variety of terrestrial and aquatic plants and animals. -The aquatic fauna includes prawns, crabs and molluscs. -Sea grass beds are also feeding ground for endangered species -The Kisite Mpunguti Marine Reserve has been established to protect and conserve some of the endangered species

Parameters	Lamu County	Tana River County	Kilifi County	Mombasa County	Kwale County
Environmental Challenges & Risks	- All counties under study face similar environmental threats and risks as shown below: - -Flooding -Insecurity and Tsunami Terrorism:	- All counties under study face similar environmental threats and risks as shown below: - -Flooding -Insecurity and Terrorism: - Tsunami:	- All counties under study face similar environmental threats and risks as shown below: - -Flooding -Insecurity and Terrorism: - Tsunami:	- All counties under study face similar environmental threats and risks as shown below: - -Flooding -Insecurity and Terrorism: - Tsunami:	- All counties under study face similar environmental threats and risks as shown below: - -Flooding -Insecurity and Terrorism: - Tsunami:
Demographics	-cosmopolitan population -indigenous communities made of Swahilis, Arabs, Korei, Boni & Ormas and migrant communities from the rest of the country. - population projected in 2012 stands at 112,551 persons	- population census of 2009, the total population was 240,075, with 119,857 males and 120,218 females. -County comprises of the dominant Pokomo and Orma tribes, and Wardei Tribe. -Other communities along the coastal areas of the county include the Mijikenda, Waata, Awer, Wailwana, and Malakote	- population was estimated to be 1,217,892 in 2012 as projected in the Kenya Population and Housing Census 2009, - composed of 587,719 males and 630,172 females. - county is home to the Waata and Swahili who are classified as vulnerable and marginalized.	- population of the county in 2009 was 939,370 persons of which 484,204 and 455,166 were male and female respectively - various settlement schemes namely Mwakirunge, Jomvu-Kuu, Bububu-A, Shika-adabu, Vyemani, Mwembelegeza and Majaoni	- total population of Kwale County is projected to be 713,488 persons in 2012 comprising of 346,898 males and 366,589 females - County is home to the Waata, Wakifundifundi, Washayu Watwaka/ Wachwaka and Duruma who are identified as vulnerable and marginalized groups in Kenya.
Electricity grid infrastructure	- connected to the National Grid through the Rabai-Malindi-Garsen – Lamu 220kV Transmission Line	- connected to the grid through the Garsen – Hola - Garissa 220kv Transmission Line and Rabai- Malindi-Garsen- Lamu 220kV Transmission Lines with an operational 220/132/33kV substation at Garsen	- connected to the National Grid with an operational 220/132/33kV substation located in Malindi. - plans to set up a 400kV substation at Mariakani connected to Rabai Power Station	- The Kipevu power plant produces power which is fed into the national grid. - plans to construct an 800MW LNG power plant in Dongo Kundu grid area. - Nairobi 400/220kV Transmission Line that connects Mombasa to	- As at 2013, the County had 10.6 per cent of households having electricity connections. - towns along the major road have access to electricity, which is unreliable due to frequent interruptions that affect investment and productivity in the county. - Inadequate distribution of rural electrification stifles local

Parameters	Lamu County	Tana River County	Kilifi County	Mombasa County	Kwale County
		and a planned one at Hola.		Isinya 400/220kV substation. - Plans are underway to build more transmission lines in connecting the County such as: Mariakani Dongo – Kundu 400 kV Transmission Line, Rabai – Bamburi 132 kV Transmission Line.	development efforts and stagnates the economy. -county relies on the national grid for its electricity need and has the potential for production of its own solar and small-scale hydroelectric energy, which has not been exploited. KETRACO is however planning to put a line connecting Kwale at Lunga to Galu via a 132kV line with a 132/33kV substation at Lunga
Transport support infrastructure	- total road network of 688.6km, and only 6km of this is tarmacked, -8 main jetties inter link the mainland to Islands and between Islands. - There are 13 airstrips: 11 public and 2 private. -Manda is the main airstrip with 3 airline companies providing daily passenger flights	- total road network in the county is 3,377km with about 55% in motorable condition. - The total road network is composed of 1,108km (class A – E) of classified roads and 2,269km (class U) of unclassified roads. -Out of this only 449km is bitumen surfaced.	- entire road network covers about 3000Kms. Of this 1,320 km is rural classified network, about 450kms is national classified network and the rest are unclassified. - Approximate 30km of rural county roads are to bitumen standards, 220Km of rural county roads are gravelled and the rest are earth roads. -county has Malindi airport, Kilifi and Kijipwa airstrips	- more than 300km of bitumen surface roads, 250 km of gravel roads and 91 km of earth surface roads -Likoni Ferry links the island to Likoni and subsequently to Kwale and Tanzania through Lunga-Lunga Border. -has 10k of railway line and 3 railway stations. -The port of Mombasa is a key resource and gate way to the East and Central African Regions. - international airport and airstrips in Kisauni sub-county	-total of 1,483.1km of classified roads of which 187.7km are bitumen surface (paved surface), 425.2km is gravel surface and 871.2km of earth surface roads/rural access roads. -international trunk road traverses the county from Mombasa to Lunga on the Kenya – Tanzania border. - There are 4 kms of railway line - 4 airstrips at Ukunda/Diani, Shimba Hills National Reserve, Msambweni and Kinango - small port at Shimoni and Vanga mostly used for water transport by boats controlled by Kenya Wildlife Service. - Water transport potential in the county remains largely unexploited

Table 3-4: Main Rivers in Kwale County

River	Source	Areas Traversed	Volume M3/D	Quality	Destination
Marere	Marere Spring Shimba rain forest	Shimba Hills National Park	9087	Good	Indian Ocean at Bombo Creek
Pemba	Marere Spring Kinango area	Kinango-Tsunza	7605	Good saline at destination	Indian Ocean at Bombo Creek
Mkurumudzi	Shimba Hills	Shimba Hills – Msambweni	9917	Good saline at destination	Indian Ocean at Gazi - Msambweni
Umba	Usambara Mountains	Lunga-lunga – Vanga	6104	Good saline at destination	Indian Ocean at Vanga
Ramisi	Chenze Ranges	Mwereni – Shimoni	8190	Good saline at destination	Indian Ocean at Bod/Shimoni
Mwachema	Majimboni-Msulwa	Majimboni-Gombato – Diani	341.73	Good saline at destination	Indian Ocean at Diani
Mwache	South Samburu	South Samburu	-	Good saline at destination	Indian Ocean at Mazeras

Source: (Kwale County CIDP, 2013)

Ground water potential is a function of rainfall and porosity of the underlying rock. Its quality is largely determined by the geology of the area. The Duruma sandstone series occupy a great part of the middle area of the region, Kinango and Samburu Divisions. Most of underground water in this series is saline and found in greater depths.

The coastal belt has a great potential of potable underground water with six main underground water catchments and/or reservoir.

a. **Tiwi Catchment:** The aquifer has a width of 20 km with good quality water. It has a through flow of 42,000m^2/hr. This reduces to 25,000m^2/hr to the north of Ng'ombeni due to decrease in permeability (GoK 1999). Of the total capacity, only 20,000m^3/day is obstructed through shallow boreholes and the National Water Conservation and Pipeline Corporation.

b. **Msambweni Catchment:** this covers about 42 km^2 with a through flow of 27,440m^3/hr. Out of the total capacity, only 13,720m^3/hr can be obstructed without changes in water quality during the dry spell. Currently 17,800m^3/day is obstructed through 251 shallow boreholes (GoK 1999).

c. **Diani Catchment:** The aquifer covers 19 km^2 and has a very low recharge due to high clay content which decreases permeability. It has a through flow of 1400m^3/hr. A number of shallow boreholes have been drilled in the area.

d. **Ramisi Catchment**: This is a very large catchment that reaches westward to include outcrops of the Duruma sandstone series. Due to this reason surface runoff are saline.

e. **Mwachema Catchment:** It has low potential for fresh water due to increased clay content and sea water intrusion

f. **Umba and Mwena Catchments:** The underlying geology of this area consists of the Duruma sandstone series, which is highly mineralized. Water in these catchments, therefore, is saline (Kwale County, 2013).

3.7.4 NPP Site Selection

3.7.4.1 Criteria for Siting of Nuclear Installations

The national Site Selection Team developed a detailed Criteria document, applicable to the siting of nuclear installations (NPPs, Research Reactors, and associated facilities) in Kenya. The Criteria is based upon international safety standards outlined by the International Atomic Energy Agency's (IAEA) *Site Survey and Site Selection for Nuclear Installations* Specific Safety Guide No. SSG-35 (2015).

According to the Criteria document, there are two processes relating to the safety considerations for the site of a nuclear installation namely: siting and site evaluation processes. These two processes are further divided into five stages:

I. Site survey
II. Site selection
III. Site characterization (site verification and site confirmation)
IV. Pre-operational
V. Operational

The siting process for a nuclear installation consists of the first two stages, i.e. site survey and site selection (see Fig. 3-7 below).

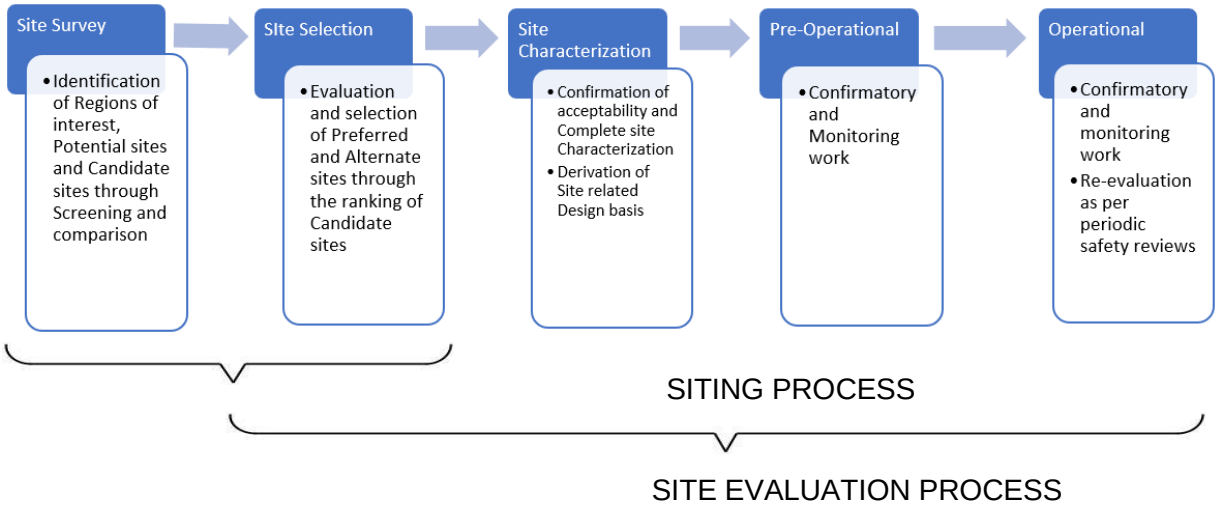

Figure 3-8: Stages in the Siting and Site Evaluation process for a nuclear installation

In the **site survey stage**, regions are investigated to find potential sites and to identify a number of candidate sites. The **second stage is site selection**, in which the candidate sites are assessed by screening and comparing them on the basis of safety and other considerations to select the preferred and alternate site.

Site evaluation is the process that extends from: (a) the last stage of the siting process; to (b) the detailed site characterization stage for the selected site to confirm its suitability, its characterization and derivation of the site related design basis for nuclear installations; to (c) the confirmation and completion of the assessment at the pre-operational stage for the installation (i.e. during the design, construction, assembly and commissioning stages); and finally to (d) the operational stage of the installation included within the framework of periodic safety review.

3.7.4.2 Siting Activities for Kenya's NPP

The process applied by the SST in siting for NPPs in Kenya follows the prescription by the Nuclear Power & Energy Agency (N*u*PEA)[1] and involved:

I. Regional Analysis

[1] Nuclear Power Energy Agency (2019). *Criteria for siting of Nuclear Installations in Kenya*. Nairobi, Kenya.

II. Screening
III. Evaluation, Comparison and Ranking.

3.7.4.2.1 Regional Analysis

The SST collected data on Kenya's geology, seismology, tectonics, soils, vegetation, hydrology, demographics and urbanization, transport infrastructure (roads, rail, ports, airports), electric grid network, socio-economics (tourist sites, national parks/reserves), environmental assets (RAMSAR sites, wildlife areas, floodplains/wetlands) and security. These datasets were compiled and analysed on the ArcGIS 10.4 platform, and detailed maps generated.

Regional analysis studies in Kenya's involved the application of regional criteria to eliminate regions in Kenya that are unsuitable for an NPP based on factors like seismicity, geology, volcanism, wildlife, Ramsar sites and tourist areas, an adequate heat sink and security.

Afterwards, avoidance criteria was applied to the suitable regions based on factors like population density, presence of oil pipelines, flooding potential and suitable foundation characteristics. Potential areas were then identified, and reconnaissance field visits conducted.

The results of the field visits culminated in the identification of a total of eight (8) potential sites in Kenya's Coast region, sixteen (16) potential sites in the Lake Victoria region and five (5) potential sites in the Lake Turkana region.

3.7.4.3 Screening Analysis

The twenty-nine (29) NPP potential sites in Kenya were then subjected to a screening (elimination) process, first using exclusionary criteria like capable faults, volcanic hazards and feasibility of implementation of an emergency plan. Afterwards, discretionary criteria like access to the national electric grid and transport infrastructure was applied.

An example of how capable faults were used as an exclusion criterion in the Lake Victoria region. Any site/s that was located on or within the capable fault 8 km screening distance (e.g. Site 1, Site 2, Site 3, Site 8, Site 9 and Site 12) was screened out and disqualified from ranking.

Another example of how capable volcanos was used as an exclusion criterion is for the Lake Victoria region. Any site/s that was located on or within the 5 Km screening radius of a Holocene volcano (e.g. Site 16) was screened out and henceforth disqualified from ranking. Any site/s located within the 15Km discretion radius, and which was vulnerable to volcano-induced events (lahars, pyroclastic density currents, landslide tsunamis) e.g. Site 8 and Site 9 was also screened out and disqualified from ranking.

An example of how Feasibility of Implementation of an Emergency Plan was used as an exclusion criterion is for the Coast Region. Any site/s whose 16Km Emergency Planning Zone (EPZ) extended outside the Republic of Kenya's international borders (e.g. Site E and Site F) was screened out and disqualified from ranking because of the associated logistical difficulties in effecting evacuations in neighboring Countries in case of an emergency. The assumption here is that a conventional large (1000MWe) NPP requires an EPZ at least 16KM in radius.

The remaining thirteen (13) sites are Candidate Sites for NPPs in Kenya and were then used in the next step of ranking based on discretionary criteria using the Analytical Hierarchy Process (AHP) to obtain the Preferred and Alternate Candidate Site for each of the three regions.

3.7.4.4 Evaluation, Comparison and Ranking

Ranking of the NPP candidate sites in Kenya was accomplished using a Microsoft Excel-based Analytical Hierarchy Process (AHP) tool, with pre-programmed cells to allow for easy data input, instant calculations and display of the results.

The analysis was based on four critical factors: Risk to safety in case of an event, the cost of mitigation, the cost of remediation and the socioeconomic impact. These factors were subjected to a pairwise comparison matrix in order to gauge their relative importance (weights).

Table 3-5: Critical Factors applied in the Siting of NPPs in Kenya

	Risk to safety in case of an event	Cost of mitigation	Cost of remediation	Socio-economic impact	Total
Risk to safety in case of an event	1	3	2	2	8
Cost of mitigation	0.333333333	1	2	3	6.33333333
Cost of remediation	0.5	0.5	1	0.333333333	2.33333333
Socio-economic impact	0.5	0.333333333	3	1	4.83333333
					21.5

Thereafter, a number of parameters were identified and prioritized based on their impact on the four critical factors. These are: **Seismic Hazard, Human induced events, Electric Grid Accessibility, Population characteristics, Environmental issues, Flooding, Transport infrastructure** and **Nuclear security**. These factors were then subjected to a pairwise comparison matrix to gauge their relative importance (weights) using SST expert elicitation. The results are illustrated in Table 3-6 below:

Table 3-6: Pairwise Comparison of factors used in Siting of NPPs in Kenya

Normalized Pairwise Comparison Matrix

Criteria	Faulting/ Seismicity	Human Events	Electric Grid	Population	Environment	Flooding	Transport infrastructure	Security
Faulting/ Seismicity	0.15211	0.15211	0.15211	0.15211	0.15211	0.15211	0.15211	0.15211
Human Events	0.15073	0.15073	0.15073	0.15073	0.15073	0.15073	0.15073	0.15073
Electric Grid	0.09425	0.09425	0.09425	0.09425	0.09425	0.09425	0.09425	0.09425
Population Density	0.05960	0.05960	0.05960	0.05960	0.05960	0.05960	0.05960	0.05960
Environment	0.11088	0.11088	0.11088	0.11088	0.11088	0.11088	0.11088	0.11088
Flooding	0.15731	0.15731	0.15731	0.15731	0.15731	0.15731	0.15731	0.15731
Transport Infrastructure	0.06965	0.06965	0.06965	0.06965	0.06965	0.06965	0.06965	0.06965
Security	0.20547	0.20547	0.20547	0.20547	0.20547	0.20547	0.20547	0.20547
Sum	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Afterwards, each of the candidate sites in the Coast region, Lake Victoria region and the Lake Turkana region, were awarded points for each of the ranking factors like faulting, flooding, security and a subsequent site ranking performed.

The ranking factors applied during ranking were as follows: -

a) Access to the electric grid
b) Flooding potential
c) Proximity to environmentally sensitive areas (ESAs)
d) Earthquake ground motion (PGA)
e) Distance from Capable faults
f) Distance from Capable volcanos
g) Geotechnical/Foundation conditions
h) Topography
i) Population density

j) Security
k) Access to Transport Infrastructure
l) External Human Induced Events
m) Tsunami/Seiche hazard

3.7.5 Results

3.7.5.1 Coast Region

In the Coast region six (6) sites were analysed namely Site A, Site B, Site C, Site D, Site G and Site H. The results generated using AHP for ranking are shown below:

Table 3-7: AHP Analysis results for the Coast Region

SITE	SCORE	POSITION
Site A	0.138675357	6
Site B	0.192576414	2
Site C	0.143808665	4
Site D	0.184820341	3
Site G	0.199060207	1
Site H	0.141059015	5

3.7.5.2 Lake Victoria Region

The analysis of the Lake Victoria region involved ranking for a total of four (4) candidate sites namely Site 4, Site 6, Site 14 and Site 15. The results are presented below:

Table 3-8: AHP Analysis results for the Lake Victoria Region

SITE	SCORE	RANK
Site 4	0.256438624	2
Site 6	0.441463377	1
Site 14	0.089189084	4
Site 15	0.212908915	3

3.7.5.3 Lake Turkana Region

In the Lake Turkana Region, a total of three (3) candidate sites were analyzed namely Site T-1, Site T-2 and Site T-3. The sites were ranked using AHP and the results presented below:-

Table 3-9: AHP Ranking results for the Lake Turkana Region

SITE	SCORE	RANK
Site T-1	0.455391176	1
Site T-2	0.257090148	3
Site T-3	0.287518676	2

3.7.5.4 ***Sensitivity Analysis***

In the Coast region, Site G scored highest in the ranking. This can be attributed to Site G being located in the sparsely populated and aseismic Lamu basin and the fact that major geologic faults occur very far from the site.
However, considering aspects like the topography, geology and flood risk, Site G (in Lamu County) was avoided, because the cost of corrective engineering measures would increase the NPP Construction costs. Thus, Site B is the Preferred Site, followed by Site D.

3.7.5.5 ***Future Plans***

Currently, N*u*PEA is undertaking activities towards carrying out preliminary site investigations, to determine the most optimal site for an NPP, out of the two Preferred Sites.
The optimal site will thereafter undergo detailed site characterization, and a Site Evaluation Report (SER) prepared, as part of the application for an NPP Site License. The investigations shall be supervised by the SST.

4 CHAPTER FOUR: POLICY, LEGISLATIVE AND INSTITUTIONAL FRAMEWORKS AND PPP ANALYSIS

4.1 Introduction

This chapter outlines a description of the existing policy, legal and institutional frameworks and PPPs related to the nuclear sector in Kenya in order to determine readiness-status, in-view of socio-environmental and sustainability sensitivity criteria in KNPP. The report scopes out and reviews the effective policy, legal, plans, programmes, and the institutional framework, evolving as foundations of KNPP.

Broadly, the objective of national energy policy in Kenya, is to “ensure adequate, quality, cost effective and affordable supply of energy that meet development needs, protect and conserve the environment, and use natural energy resources”. In Kenya, the natural resources available for exploitation include small hydro, geothermal, coal, biomass, biogas, cogeneration, tidal waves, solar, wind and the discovered recently, petroleum.

To meet current energy demand, Kenya imports petroleum fuels from Middle East, and electricity from Uganda and Tanzania. GoK has embarked on these broad objectives to mitigate the current situation in the medium term:

- Diversification of the Kenya’s energy sources in order to lessen dependence on unsustainable and unreliable sources like hydro power;
- Development, rehabilitation and expansion of generating power plants;
- Regional interconnections;
- Expansion and extension of the national grid; and,
- Energy efficiency and conservation.

4.2 The Kenya Vision 2030

Nationally, the proposed Nuclear Power Programme links well with Vision 2030 blueprint. The National development blueprint recognizes increased energy demand in Kenya and thus need to generate more power to meet the development needs at a lower energy cost.

The economic pillar of Vision 2030 seeks to improve the prosperity of all regions of the country and all Kenyans and as such, the development blueprint recognizes projects such as the proposed KNPP to be a prerequisite in attaining the Kenya’s Vision 2030 through provision of reliable energy.

Moreover, environment’s cleanliness and security is ensured via protection and conservation of sensitive areas such as wetlands, forests, wildlife corridors, and migratory routes, which can be done by conducting specific project’s environmental and social impact assessments, and developing of comprehensive mapping of land use patterns in Kenya (GoK, 2008).

4.3 The Government of Kenya’s Big Four Agenda

The Big Four Agenda entails enhancing manufacturing sector, providing affordable housing, providing universal health coverage and enhancing food and nutrition security. The proposed Nuclear Power programme comes in handy and is in consistence with the Big Four Agenda through provision of adequate enabling environment to drive the agenda by provision of reliable and affordable energy.

4.4 Key Policies relevant to the SESA

4.4.1 Sessional Paper No. 10 of 2014 on the National Environment Policy

The Republic of Kenya has a policy, legal and administrative framework for environmental management. The broad objectives of the national environmental policy in Kenya are: -

- To ensure optimal use of natural resources while improving environmental quality.
- To conserve natural resources such that the resources meet the needs of the present without jeopardizing future generations in enjoying the same.
- To develop awareness that inculcates environmental stewardship among the citizenship of the country.
- To integrate environmental conservation and socio-economic aspects in the development process.
- To ensure that national environmental goals contribute to international obligations on environmental management and social integrity.

To achieve this, it is a policy direction that appropriate reviews and evaluations of proposed Nuclear Power programme and operations are checked to ensure compliance with the environmental policy (GoK, 2013).

4.4.2 National Wetlands Conservation and Management Policy, 2014

The policy aims at integrating both local and expert knowledge while upholding the principle of public participation as entrenched in the National Constitution. The policy therefore seeks to secure and ensure the benefits of wetlands for posterity. It also aims at providing a framework for mitigating and tackling the diverse challenges that affect wetlands conservation and wise use in Kenya. In addition, the policy fulfils Kenya's obligations under the RAMSAR Convention and the East Africa Community (EAC) among other instruments. The Nuclear Power Programme is therefore expected to jointly support the implementation of the policy to sustain healthy wetland ecosystems within the proposed development area for community livelihoods and biodiversity conservation (GoK, 2014).

4.4.3 Wildlife Policy, 2011

The wildlife policy is aimed at promoting protection and conservation of wildlife in Kenya, both in protected and non-protected areas. The policy is implemented by the Kenya Wildlife Service (KWS). The proposed Nuclear Power Programme will need to be consistent with this policy. Where wild animals will be disturbed during the Programme implementation phase appropriate mitigation measures must be implemented to minimize disturbance to wildlife (GoK, 2007).

4.4.4 National Energy Policy, 2018

This policy was formulated to beef up the Sessional Paper No. 4 on Energy. The overall objective of the policy is to ensure affordable, competitive, sustainable and reliable supply of energy to meet national and county development needs at the lowest cost, while protecting and conserving the environment.

S4.4.7.1 (2) of the policy recognizes that that nuclear sector can produce enormous amounts of electricity at a relatively economical cost. On solar energy, the policy recommends that there should be regular review of standards for solar energy technologies and equipment, provision of a framework for connection of electricity generated from solar energy to national and isolated grids, through direct sale or net metering and Research Development and Dissemination (RD&D) should be undertaken on solar technologies. The proposed KNPP is therefore expected to directly bring to effect the key objectives of the Policy (GoK, 2018).

4.4.5 HIV/AIDS Policy of 2009

The policy identifies HIV/AIDS as a global crisis that constitutes one of the most formidable challenges to development and social progress. The pandemic heavily affects the Kenyan economy through loss of skilled and experienced manpower due to deaths, loss of man hours due to prolonged illnesses, absenteeism, reduced performance, increased stress, stigma, discrimination and loss of institutional memories, among others. Due to the large of number of workers who will be involved in the implementation of the KNPP and the associated social issues expected in the proposed city, HIV/AIDS policy aspects will be considered (GoK, 2009).

4.4.6 Forestry Policy, 2014

This policy of the government is intended to ensure forests in the country are protected from wanton destruction. The goal of the policy is to increase the area under forest to 10% of the total land area in the country. The proposed KNPP will therefore be required to be consistent with the Kenya's forest policy. Where clearance of forests or sections of forests is envisaged, it would be important to put in place appropriate mitigation measures such as those specified in the preliminary environmental management and monitoring plan of this SESA report (GoK, 2014).

4.4.7 Sessional paper no. 9 of 2012 on the National Industrialization Policy Framework for Kenya 2012-2030

The Vision of this policy aims to make Kenya the leading industrialized nation in Africa with a robust, diversified and globally competitive manufacturing sector. The mission is: "to promote and sustain a vibrant, globally competitive and diversified industrial sector for generation of wealth and employment through the creation of an enabling environment". The implementation of this Sessional Paper is premised on the guiding principles namely: (i) Productivity and competitiveness; (ii) Market development; (iii) High value addition and diversification; (iv) Regional dispersion; (v) Technology and innovation; (vi) Fair trade practices; (vii) Growth and graduation of Micro, Small and Medium Industries; (viii) Employment creation; (ix) Environmental sustainability; (x) Compliance with the current Constitution; and (xi) Education and human resource development. All these principles are in line with the envisioned development and will form key tenets in the KNPP, key of them being provision of reliable electricity to meet the National Industrialization Plans (GoK, 2012).

4.4.8 Sessional Paper No. 3 of 2009 on National Land Policy

The policy is guided by the environmental management principles which are aimed at restoring the environmental integrity through introduction of incentives and encouragement of use of technology and scientific methods for soil conservation, among others. The policy further requires fragile ecosystems to be managed and protected by developing a comprehensive land use policy bearing in mind the needs of the surrounding communities. The policy also requires zoning of catchment areas to protect them from degradation and establishment of participatory mechanisms for sustainable management of fragile ecosystems. The policy also called for development of procedures for co-management and rehabilitation of forest resources while recognizing traditional management systems and sharing of benefits with contiguous communities and individuals. Lastly, all national parks, game reserves, islands, front row beaches and all areas hosting fragile biodiversity are declared as fragile ecosystems under the policy.

The policy recognizes that sustainable management of land based natural resources depends largely on the governance system that defines the relationships between people, and between

people and resources. To achieve an integrated approach to management of land-based natural resources, all policies, regulations and laws dealing with these resources need to be harmonized with the framework established by the Environmental Management and Coordination Act (EMCA Cap 387).

The policy also addresses land management particularly in Section 3.4.3.2 on ecosystem protection (including wetlands). Measures for protection are required for fragile ecosystems. The policy also calls for the protection of watersheds, lakes, drainage basins and wetlands. The policy prohibits settlement and agricultural activities in water catchment areas and calls for identification, delineation and gazettement of all water courses and wetlands. The fact that the KNPP's candidate sites are situated in areas of ecological sensitivity calls for adequate planning is in line with the aims of the land policy. The developers will be required to adhere to the requirements of the land use policy in order to ensure a sustainable and equitable use of land. The proposed KNPP should address issues such as land degradation, pollution, water pollution, nuclear waste management, soil erosion and come up with proper strategies to ensure protection of the ecosystem and a sustainable use of available land (GoK, 2012).

4.4.9 The Sessional Paper No. 1 of 2017 on National Land Use Policy (NLUP)

The policy outlines how land in Kenya should be utilized efficiently, equitably, productively and sustainably for the current and future generations. It provides a framework for adequately addressing the challenges related to the use of land and land-based resources. Implementation of the policy will help in the conservation of water catchment areas, mitigating climate change effects in order to have a reliable and steady rainfall for sustained water supply for human settlement, manufacturing and agriculture. The policy provides a guide for preparation of physical development plans at the county level and provide for renewal and re-development of urban areas. The KNPP will be subjected to the provisions of this policy in order to ensure proper utilization of the available land (GoK, 2017).

4.4.10 National Policy for Disaster Management in Kenya

The policy lays emphasis on preparedness on the part of the Government, communities and other stakeholders in Disaster Risk Reduction (DRR) activities. In this regard, the policy aims at the establishment and strengthening of Disaster Management institutions, partnerships, networking and main streaming Disaster Risk Reduction in the development process so as to strengthen the resilience of vulnerable groups to cope with potential disasters. The proposed KNPP is therefore required to be in line with the provisions of disaster management due to the inherent nature of NPPs and historical nuclear related disasters. Adequate and informed planning will be required to ensure disaster preparedness is implemented during planning. Key aspects of the policy that the KNPP should consider are the two major categories of disasters; 1) Natural: geologic and climatic disasters (e.g., floods, landslides, storm surges, coastal erosions, earthquakes, volcanicity. 2) Human-made: terrorism, nuclear accidents, fires, nuclear material transport accidents, civil failure, corruption, resource-based and political conflicts, and other emerging disasters (GoK, 2009).

4.4.11 The National Water Policy of Kenya 1999

The policy aims to achieve sustainable development and management of the water sector by providing a framework in which the desired targets/goals are set, outlining the necessary measures to guide the entire range of actions and to synchronize all water-related activities and sectors. The policy set the following specific policy objectives covering the four basic areas of water resources management, water supply and sewerage development, institutional

arrangement and financing of water sector: The KNPP should therefore ensure its objectives are aligned with the key water policy objectives stipulated below;

- Preserve, conserve and protect all available water resources and allocate it in a sustainable, rational and economical way;
- Supply of water of good quality and in enough quantities to meet the various water needs including poverty alleviation, while ensuring safe disposal of wastewater and environmental protection;
- Establish an efficient and effective institutional framework to achieve a systematic development and management of water sector; and
- Develop a sound and sustainable financing system for effective water resources management, water supply and sanitation development (GoK, 1999).

4.4.12 Sessional Paper No. 1 of 2008 on National Oceans & Fisheries Policy

Section 3.1.2 gives provision on ensuring increased and sustainable fish production and utilization by properly managing the Ocean and other Kenya Fishery waters. The policy is vital addressing the following issues: regional environmental conflict: alignment to the EAC: environment and natural resources protocol and alignment to the Nairobi Convention (GoK, 2008).

4.4.13 Integrated Coastal Zone Management (ICZM) Policy 2017

The purpose of this policy is to provide for sustainable management of the coastal line. It gives policy guidelines on conservation of coastal and marine resources; protection of the mangrove forests; protection of coral reefs and sea grass beds; protection of delta; protection of coastal natural and cultural heritage and minimizing impacts of coastal shorelines. The Policy will be therefore key handling the following issues Impact on the coral reefs: impact on deltaic ecosystems; impact on ecosystem services; alignment with the Nairobi Convention and regional environmental conflicts (GoK, 2017).

4.4.14 Kenya National Policy on Gender and Development (NPGD), 2000

The purpose of the Gender Policy is to institutionalize The Kenya National Policy on Gender and Development (NPGD), within Gender, Children and Social Development. It articulates the policy approach of gender mainstreaming and empowerment of women at the ministry level. The policy seeks a society where women, men, children and persons with disabilities enjoy equal rights, opportunities and a high quality of life. This report has in depth addressed matters to do with gender and development and in the concession the KNPP should be guided by respective principles under this policy (GoK, 2000).

4.4.15 The National Occupational Health and Safety Policy

The major purpose of this policy is to significantly sustain continual development and implementation of the National Occupational Safety and Health systems and programmes to reduce incidences of work related accidents and diseases as well and seek to offer equitable compensation to those who suffer physical injuries and contract occupational diseases. The objectives of this policy will guide the development of the nuclear energy EHS policy and strategic plans. The objectives for this policy are: -

- To guide the development of laws, regulations and any other instruments on occupational safety and health.
- To recommend establishment and strengthening of responsible and accountable institutions for management of occupational safety and health

- To recommend an enforcement and compliance mechanisms for occupational safety and health laws and regulations
- To create mechanisms for cooperation between employers, workers and their representatives at workplaces in the promotion of occupational safety and health.
- To strengthen capacities of state and non-state actors in occupational safety and health
- To create a resource mobilization mechanism for the implementation of this policy
- To initiate programmes to disseminate occupational safety and health information and advisory services
- To put in place programmes for publicity and awareness creation on occupational safety and health issues
- To strengthen research capacity in Occupational Safety and Health
- To develop a comprehensive information system for collection, analysis, storage, retrieval and dissemination of data on work-related accidents, diseases and work injury Compensation
- To initiate support programmes for continued improvement of occupational safety and health practices and conditions in micro and small enterprises and the informal sector of the economy
- To establish programmes for collaboration with relevant insurance or social security schemes in compensation for work related injuries and diseases, and rehabilitation of injured workers
- To mainstream occupational safety and health in learning institutions and communities
- To institutionalize social dialogue and partnership on occupational safety and health.
- To mainstream occupational safety and health in all sectoral and cross sectoral development issues (GoK, 2012).

4.5 National Strategies

4.5.1 The Kenya National Climate Change Response Strategy of 2010

This strategy provides measures that the Government of Kenya is taking to address issues related to the impact of climate change on various sectors of the economy. The KNPP will need to take on board the effects of changing climate in the country and apply climate change mitigation measures. It will be a stride towards lessening the overreliance on fossil fuels a source of energy thus reducing the greenhouse gas (GHG) emissions to the atmosphere (GoK, 2010).

4.5.2 The National Biodiversity Strategy of 2000

The National Biodiversity Strategy and Action Plan (NBSAP) was formulated to enable Kenya address national and international commitments defined in Article 6 of the Convention on Biological Diversity (CBD). The strategy is a national framework of action for ensuring that the present rate of biodiversity loss is reversed, and present levels of biological resources are maintained at sustainable levels for posterity. The general objectives of the strategy are to conserve Kenya's biodiversity; to sustainably use its components; to fairly and equitably share the benefits arising from the utilization of biological resources among the stakeholders; and to enhance technical and scientific cooperation nationally and internationally, including the exchange of information in support of biological conservation. The KNPP will need to comply with the requirements of this strategy since the land uses may interfere with biodiversity in some sections along the wetlands in its areas of operation (GoK, 2000).

4.5.3 National Wildlife Strategy, 2030

The National Wildlife Strategy identifies four pillars of essence in wildlife conservation: Resilient ecosystems; engagement by all Kenyans; evidence-based decision making; and Sustainability and Governance.

The strategy outlines a transformative vision for Kenyans' active participation and equitable benefit sharing from the wildlife resource. It is anchored on clear targets and a collaborative implementation framework. The strategy is a response to the chronic and emerging challenges facing wildlife.

It provides a framework for coordination and implementation of Article 69 of the Constitution of Kenya (2010) and the Wildlife Conservation and Management Act (2013) and articulates an ambitious vision that "Kenyans value a wildlife that is healthy and resilient to threats." It further provides a mechanism to coordinate the wildlife sector and implement the Wildlife Conservation and Management Act (2013). It is designed to bring Kenyans together through a shared vision for wildlife as a cornerstone to Kenya's social, cultural, environmental, and economic development. In addition, the strategy provides a collaborative framework for implementation and cross-sectorial coordination (GoK, 2018).

4.5.4 The National Water Master Plan 2030

The National Water Master Plan (NWMP) 2030 was launched on 26th March 2014. It is a product of an intensive study of Kenya's water resources and meteorological conditions to facilitate planning for development and management of the same. The objectives of the master plan were: To assess and evaluate availability, reliability, quality, and vulnerability of the country's water resources up to around 2050 taking into consideration climate change; To renew the National Water Master Plan towards the year 2030 taking into consideration climate change; To formulate an action plan for activities of WRA up to 2022 to strengthen their capability; To strengthen the capacity of water resources management through transfer of technology.

NWMP 2030 has been prepared for six catchment areas which are management units of WRA. These include; Athi Catchment Area (ACA) – Machakos; Ewaso Ng'iro North Catchment Area (ENNCA) – Nanyuki; Lake Victoria North Catchment Area (LVNCA) – Kakamega; Lake Victoria South Catchment Area (LVSCA); Rift Valley Catchment Area (RVCA) – Nakuru and Tana Catchment Area (TCA) – Embu. The NWMP 2030 consist of the following nine component plans: a) Water Supply Development Plan; b) Sanitation Development Plan; c) Irrigation Development Plan; d) Hydropower Development Plan; e) Water Resources Development Plan; f) Water Resources Management Plan; g) Flood and Drought Disaster Management Plan and h) Environmental Management Plan (GoK, 2013).

The proposed KNNP, since it will be in the proximity of important water basins as discussed in this report will require to be in line with the development plans and overall NWMP. NuPEA should input all strategies necessary to ensure water resources management within the preferred candidate site(s).

4.5.5 The Kenya National Spatial Plan (2015-2045)

The National Spatial Plan is a long-term plan that covers a period of 30 years and provides a spatial structure that defines how the national space is going to be utilized for the realization of optimal and sustainable use of our land. The Plan provides a spatial framework upon which the various sectoral plans and policies will be anchored and is a basis for preparation of all other lower level plans. The Plan covers the entire Kenyan territory and the Exclusive Economic Zone

(EEZ). The Plan addresses the disconnect between economic and spatial planning that has led to uncoordinated and unguided development by establishing a broad physical planning framework that provides physical planning policies to support economic and sectoral planning. The National Spatial Plan is therefore, designed to provide a national spatial planning framework for integration of social, economic and environmental policies. The KNNP should be able to adhere to the goals of the national spatial plan in order to promote planned and sustainable development. The development should achieve a balance between economic and spatial planning by bridging the gap (GoK, 2015).

4.5.6 National Master Plan for the Conservation and Sustainable Management of Water Catchment Areas in Kenya, 2012

The master plan was formulated to create a framework that will support the rehabilitation, protection and conservation of important water catchment areas in Kenya to ensure sustainable use of water resources. The proponent of the KNNP should ensure water catchment areas within the development area are conserved and protected during and after implementation of the master plan, and this will be done in collaboration with relevant stakeholders as identified in the stakeholder engagement section in the SESA report (GoK , 2012).

4.5.7 Strategic plan for the NPP in Kenya, 2013 Programme

Adopted in June 2014, 15 Year Strategic Plan seeks 'to enable Kenya to develop a successful nuclear power programme'. As opposed to traditional strategic plans that span 5 years, the longer period in this Strategic Plan was based on the lengthier lead times involved in the development of a nuclear power plant.

4.5.8 Least Cost Power Development Plan 2017-2037

Kenya's power industry generation and transmission system planning is undertaken on the basis of a 20-year rolling Least Cost Power Development Plan, updated every year. The optimal development programme is dominated by geothermal, nuclear, coal, imports and wind power plants. It projects an inclusion of 6,638 MW from nuclear energy, with the first 1000MW being commissioned in 2036.

4.5.9 Power Generation and Transmission Master Plan LTP 2015 – 2035

Kenya's PGTMP 2015-2035, provides a long-term plan of demand forecast, generation planning, transmission planning based on three scenarios of vision, reference and low scenario and a sub-scenario where are changes in Energy Efficiency (EE), are factored, to model an optimal investment planning. It looks at fossil fuels and renewables energies including geothermal, nuclear, coal, imports, wind solar and nuclear fuel power plants (MoEP, 2011).

4.6 The National Legal Structures

4.6.1 The Constitution of Kenya

The Constitution is the supreme law of the land. It lays the foundation on which the wellbeing of Kenya is founded. The constitution's provisions are specific to ensuring sustainable and productive management of land resources; transparent and cost-effective administration of land; and sound conservation and protection of ecologically sensitive areas.

Article 42: Every person has the right to a clean and healthy environment which includes: -

- To have the environment protected for the benefit of present and future generations through legislation and other measures, particularly that contemplated in article 69.
- To have obligation relating to the environment fulfilled under article 70.

Section 69 states that: The state shall;

- Encourage public participation in the management, protection and conservation of the environment.
- Establish systems of environmental impact assessment, environmental audit and monitoring of the environment.
- Eliminate processes and activities that are likely to endanger the environment.

Every person has a duty to cooperate with state organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and those of actual resources. The KNNP through the NuPEA has provisions to ensure a clean and healthy environment through the environmental and social management plan. It is also anticipated the NPP will be guided by the spirit of the Kenyan constitution considering environmental protection and conservation.

4.6.2 The Energy Act, 2019

The Act provides for the inclusion of clauses on nuclear power as from clause 54 to 72. Section 54 stipulates the establishment of a Nuclear Power and Energy Agency with a mandate on (a) being the nuclear energy programme implementing organization and promote the development of nuclear electricity generation in Kenya; and (b) carrying out research, development and dissemination activities in the energy and nuclear power sector.

4.6.3 Environmental Management and Coordination Act (EMCA Cap 387)

EMCA Cap 387 apply to all policies, plans and programmes as specified in part IV, part V and the Second Schedule of the Act. According to Part VI of the Act, section 42 (1), the lead agencies in consultation with the Authority are mandated to subject all proposals for public policy, plans and programmes to a Strategic Environmental Assessment to determine which ones are the most environmentally friendly and cost effective when implemented individually or in combination. The SESA must consider the effect of implementation of alternative policy action on the use of natural resources, protection and conservation of biodiversity, human settlement and cultural issues, socio-economic factors, the protection, conservation of natural physical surroundings of scenic beauty as well as protection and conservation of built environment of historic or cultural significance. The principles of SESA must also be incorporated in any sector or national policy development. The KNNP has been subjected to a SESA as per the requirement of these regulations. Since nuclear reactors are listed in Schedule II of EMCA as all the projects related to the KNNP are expected to be subjected to ESIA in accordance with the law. Below is a highlight of key regulations under EMCA, Cap 387.

4.6.3.1 Environmental Management and Coordination (Controlled Substances) Regulations, 2007 (Legal Notice No.73 of 2007)

These regulations provide the classification of the controlled substances by the Authority as set out to the First Schedule of these regulations. It also gives the control measures that should be put in place to ensure adequate safety of people and environment during the manufacture, storage, and transport, selling, handling and disposing of a controlled substance. The regulations also give provisions for licensing of any person who wishes to manufacture, import, and supply

or transit a controlled substance in Kenya. The KNPP will incorporate the controlled substances regulations to ensure the safety of all stakeholders.

4.6.3.2 Environmental Management and Coordination (Environmental Impact Assessment and Audit) Regulations, 2003

These regulations stipulate the steps to be followed when undertaking an Environmental Impact Assessment, and Environmental Audit. The KNPP land uses will have impacts on several environmental compartments and several considerations will have to be made when assessing them as prescribed in the Second Schedule of the regulations. All developments /projects within the Nuclear Power Plan that fall under the Second Schedule of the EMCA Cap 387, will require to undergo an Environment Impact Assessment/Audit which will be carried out in accordance with these regulations. The regulations stipulate the ways in which environment impact assessment and audits should be conducted. The project under the KNPP will have to be subject under the provisions of this regulation and undergo ESIA studies to determine the extent of their impacts and adequately mitigate the impacts. Nuclear projects are categorised under high impact projects in the EIA Regulations (Amendment of Schedule II).

4.6.3.3 Environmental Management and Coordination (Water Quality) Regulations, 2006

Water Quality Regulations apply to water used for domestic, industrial, agricultural, and recreational purposes; water used for fisheries and wildlife purposes, and water used for any other purposes. Different standards apply to different modes of usage. These regulations provide for the protection of lakes, rivers, streams, springs, wells and other water sources. The effective enforcement of the water quality regulations will lead to a marked reduction of water-borne diseases and hence a reduction in the health budget.

The regulations also provide guidelines and standards for the discharge of poisons, toxins, noxious, radioactive waste or other pollutants into the aquatic environment in line with the Third Schedule of the regulations. The regulations have standards for discharge of effluent into the sewer and aquatic environment. While it is the responsibility of the sewerage service providers to regulate discharges into sewer lines based on the given specifications, NEMA regulates discharge of all effluent into the aquatic environment. Everyone is required to refrain from any actions, which directly or indirectly cause water pollution, whether or not the water resource was polluted before the enactment of the Environmental Management and Coordination Act (EMCA Cap 387). The KNPP will use water for its construction and its operation for cooling purposes hence will incorporate these regulations to protect human health and the environment.

4.6.3.4 Environmental Management and Coordination (Waste Management) Regulations, 2006

These regulations stipulate how the different types of waste streams should be stored, transported, and disposed of. The type of waste streams described herein include solid waste, industrial waste, hazardous waste, pesticides and toxic substances, biomedical waste and radioactive substances. The regulations also stipulate the conditions for licensing any person dealing with the transport or waste disposal. The KNPP will also incorporate the waste management regulations to offer proper guidelines in waste management.

4.6.3.5 Environmental Management and Coordination (Noise and Excessive Vibration Pollution Control) Regulations, 2009

These regulations prohibit any person from making or causing any loud, unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. It also stipulates the factors to be considered when

determining the amount of noise produced from various sources. The regulations further provide the permissible noise levels within different neighbourhoods at different times. In determining whether noise is loud, unreasonable, unnecessary or unusual, the following factors may be considered:

- Time of the day.
- Proximity to residential area.
- Whether the noise is recurrent, intermittent or constant.
- The level and intensity of the noise.
- Whether the noise has been enhanced in level or range by any type of electronic or mechanical means; and,
- Whether the noise is subject to be controlled without unreasonable effort or expense to the person making the noise.

The KNPP will be guided by these regulations to ensure that all land use changes and developments envisioned in the execution of the Strategic plan for the NPP in Kenya, 2013 will comply with the provisions of the regulations.

4.6.3.6 Environmental Management and Coordination (Air Quality) Regulations, 2014

These regulations provide for the prevention, control and abatement of air pollution to ensure clean and healthy ambient air. It applies to all internal combustion engines, all premises, places, processes, operations, or works to which the provisions of the Act and Regulations made thereunder apply, and any other appliance or activity that the Cabinet Secretary may by order in the Gazette, specify. They stipulate the measures to prevent air pollution from both stationary and mobile phases. They also provide for the permissible occupational exposure limits. The KNPP will incorporate these provisions to ensure ambient air quality is attained at the development and operation stage.

4.6.3.7 The Environmental Management and Coordination (Wetlands, Riverbanks, Lakeshores, and Seashores Management) Regulations, 2009

The objective of these regulations is to ensure that the wetlands and wetland resources, riverbanks, lakeshores and seashores are used and managed in a sustainable manner. The regulations provide conditions for an area to be declared as a protected wetland and its subsequent use after the declaration. They also provide for special measures that should be undertaken to protect the riverbanks, lakeshores and seashores from degradation. These regulations will be incorporated in the KNPP to ensure that the areas such as riverbanks are protected.

4.6.3.8 Environmental Management and Coordination (Conservation of Biodiversity) Regulations, 2006

These regulations prohibit any person from engaging in any activity that may have an adverse impact on any ecosystem, lead to the introduction of any exotic species or lead to unsustainable use of natural resources without an Environmental Impact Assessment License issued by the Authority under the Act. It stipulates the measures to be undertaken in a bid to conserve any threatened species and provides for the protection of environmentally significant areas. These regulations will be incorporated in the KNPP to ensure that any species of importance within the development area will be protected.

4.7 Other relevant legislation

There are several legal provisions with provisions on environmental protection and socio-economic integrity, which touch on and regulate the development of the KNPP. A brief review of

the various legislations relevant to the development is given hereunder in Table 4-1: Other National Legal Framework Table 4-1: Other National Legal Framework .

Table 4-1: Other National Legal Framework

National Legislation	Brief Description	Relevance to the KNNP
Land Act, (amendment) 2015	Revises, consolidates and rationalizes land laws, to provide for the sustainable administration and management of land and land-based resources, and for connected purposes.	The Nuclear Power Programme (NPP) will have to consider the land tenure systems in the respective Counties traversed by the NEC
Radiation Act, Cap 243	Gives provisions for protection of the public and radiation workers from the dangers arising from the use of devices or material capable of producing ionizing radiation and for connected purposes. The Act establishes the Radiation Protection Board to oversee listening and Registration of users of ionizing radiation sources.	In the operation of NPP, there is need to ensure public protection from the effects of ionizing radiation
National Land Commission Act, 2012	Makes provision as to the functions and power of the National Land Commission, qualification and procedures for appointments to the Commission, and gives effect to the objects and principles of devolved government in land management and administration	The Nuclear Power Programme (NPP) will have to consider the land tenure systems in the respective Counties where Nuclear Power Plants may be located.
Land Registration Act, 2012	This is an Act of Parliament intended to revise, consolidate and rationalise the registration of titles to land, to give effect to the principles and objects of devolved government in land registration, and for connected purposes.	The Nuclear Power Programme (NPP) will have to consider the land tenure systems in the respective Counties where Nuclear Power Plants may be located.
Antiques and Monuments Act, Cap 215and National Museums and Heritage Act, Cap 216,	These Acts been used for gazettement of areas of historical importance, museums and threatened heritage as they protect the archaeological, historical and cultural sites such as monuments, elements or structures of an archaeological nature, inscriptions and cave dwelling.	All reasonable measures will need to be taken to ensure that the integrity of any historical monuments and objects of archaeological, paleontological, ethnographical and traditional interest along the NPP are not affected by the Implementation of the Nuclear Power Programme (NPP).
Physical Planning Act, Cap 286	The Physical Planning Act is the main statute that provides for the planning in Kenya. It provides for the various types of plans, their contents and the procedures for the preparation of the same.	The Nuclear Power Programme (NPP) should confirm to the requirements within the Physical Planning Act and land use planning. Of special significance is the need to undertake the plan through a participatory process that requires the involvement of stakeholders in the planning process
The Energy Act, 2019	Deals with all matters relating to all forms of energy including the generation, transmission, distribution, supply and use of electrical energy as well as the legal basis for establishing the systems associated with these purposes	
Forest Management and Conservation Act, 2013	The Act led to the establishment of Kenya Forest Service which is charged with management of forests in consultation with the forest owners. The body enforces the conditions and regulations pertaining to logging, charcoal making and other forest utilization activities.	The Nuclear Power Plants may be located close to forests and as such, project planning will need to ensure

National Legislation	Brief Description	Relevance to the KNNP
		that disruption of the environment in these areas is minimized and appropriate mitigation measures are established and implemented.
Water Act, 2016	Provides for the management, conservation, use and control of water resources and for acquisition and regulation of rights to use water; to provide for the regulation and management of water supply and sewerage services.	The implementation of the Nuclear Power Programme should conform to sound integrated water resource management practices.
Public Health Act (Cap 242)	This is an Act of Parliament to make provision for securing and maintaining health	The necessary public health safeguards will have to be factored into the Nuclear Power Programme.
Wildlife Conservation and Management Act (2013)	This Act establishes the different strategies to conserve and protect Kenya's Wildlife. In the Act, conservation measures and management principles are guided by effective public participation and ecosystem approach.	It is important that the Nuclear Power Programme considers participatory approach to implementing the different strategies in order to ensure sustainable development along the Wildlife Conservation regions that are managed by the Kenya Wildlife Service (KWS) - mandated by Government under this act.
Agriculture, Fisheries and Food Authority Act (2013)	This Act establishes an authority to be known as the Agriculture, Fisheries and Food Authority. That is mandated to promote best practices in, and regulate, the production, processing, marketing, grading, storage, collection, transportation and warehousing of agricultural and aquatic products excluding livestock, livestock products as may be provided for under the Crops Act, and the Fisheries Act. The Authority is also mandated to give advice the national government and the county governments on agricultural and aquatic levies for purposes of planning, enhancing harmony and equity in the sector.	The NPP must not adversely affect fisheries and food resources
Occupational Safety and Health Act, 2007 (OSHA)	The purpose of this Act is to secure the safety, health and welfare of persons at work, and protect persons other than persons at work against risks to safety and health arising out of, or in connection with, the activities of persons at work.	NPP must be operated in accordance with the OSHA throughout all the phases (construction, operation, decommissioning)
Work Injury Benefits Act (WIBA) Chapter 236	This Act privileges employees for conditional compensation for work related injuries and diseases contracted in the course of their employment and for connected purposes. The legibility includes the loss of their wage-earning capacity in the work at which they were employed at the time of accident.	
Prevention and Control of	This Bill gives effect to the Constitution, international treaties and conventions on marine pollution, provide for the prevention, mitigation and	The NPP must not adversely affect marine resources

National Legislation	Brief Description	Relevance to the KNNP
Marine Pollution Act, 2014	control of pollution of the sea from ship transport operations, preparedness and response for pollution emergencies arising from ship transport operation, liability and compensation for pollution damage arising from shipping transport operations or pollution damage resulting from exploration and exploitation of seabed mineral resources and for connected purposes.	
The Community Land Act, 2016	The Act provides for the recognition, protection and registration of community land rights; management and administration of community land; to provide for the establishment of and the powers of community land management committees; to provide for the role of county governments in relation to unregistered community land and for connected purposes. Part V to VIII of the Bill are key to NPP on Community Land. These parts give provisions on guidelines on: - Conversion of community land for public use; - Special rights and entitlements in the community land; - Environment and natural resources management (natural resources on community land, benefit sharing, rules bye-laws and regulation of community land use planning) - Settlement of disputes relating to community land such as dispute resolution mechanisms, Mediation and arbitration	The NPP must not adversely possess community land
National Construction Authority Act 2011	Establishes the National Construction Authority to oversee the construction industry and its development	Construction of the NPP must comply with the NCA Act
Private Partnership Act No. 15 of 2013	Framework for private sector participation of the private sector in the financing of infrastructure and development projects.	Financing and funding of the NPP
Companies Act No. 17 of 2015	Incorporation and management of companies	Owner/Operator of the NPP
Treaty Making & Ratification Act No. 45 of 2012	Procedure for ratification of treaties	Obligatory international nuclear law instruments
Lands Act 2012	State Department of Lands charged with oversight over management of land	Facilitation of acquisition of land for the NPP

National Legislation	Brief Description	Relevance to the KNNP
County Government Act, 2012	Purpose of the Act is to give effect to the objects and principles of devolution as set out in Articles 100, 174 and 175 and 176(2) of the Constitution.	Obligates every County Government to develop an integrated plan.2
State Corporations Act, Cap 446	Instrument through which the Executive establishes State Corporations. The Nuclear Power and Energy Agency, formerly Kenya Nuclear Electricity Board (KNEB), is a State Corporation established under the Energy Act 2019. It is charged with the responsibility of promoting and implementing Kenya's Nuclear Power Programme, carrying out research and development for the energy sector.	Establishing instrument for Parastatals.
Water Act 2016	Access to water and permitting process basin on regional water basins committee, water rights and	Water Use especially where there are vulnerabilities to water access.
National Science & Technology Act No. 28 of 2013	Establishes the National Social Assistance Authority; to provide for the rendering of social assistance to persons in need and for connected purposes such as the old, those living with disabilities	Will give strength to planning, construction and operation in ensuring those that need social assistance are catered for in the programme

Source: (SGS, 2019)

4.8 The Institutional Framework

Table 4-2below shows key relevant institutions that are involved in the formulation and implementation of energy policy with their roles specified. As is the case in many countries, energy is a strategic subject, with core decisions being taken at the highest government level.

Table 4-2: General Institutional Framework

National Institutions	Responsibility	Relevance to the KNNP
Ministry of Transport and Infrastructure	• To position Kenya as the logistics hub of the region by creating a modern and efficient transport system for goods and services within the Counties and also with other countries in the region	N/A
The National Land Commission	• Manages public land on behalf of the national and county governments; • Advises the national government on a comprehensive programme for the registration of land titles; • Investigates present or historical land injustices, and recommends appropriate redress; • Encourages the application of traditional dispute resolution mechanisms in land conflicts; • Monitors/oversees land use planning throughout the country; • Ensures that public land/land under the management of designated state agencies is sustainably managed; • Manages and administers all unregistered trust land and unregistered community land on behalf of the county government; and • Develops and encourages alternative dispute resolution mechanisms in land dispute handling and management.	This Commission will be integral in the land acquisition and compensation processes as the entire procedure will be coordinated by it.
Ministry of Industrialization and Enterprise Development	• This Ministry is formulating an industrialization policy in line with vision 2030, and is • instrumental in ensuring that Kenyan goods and services find ready market in both national and County Governments	The Nuclear Power Programme will have to align with the principles of Vision 2030 as well as the County Governments
Ministry of Interior and Coordination of National Government	• This Ministry is charged with the responsibility of public administration, internal security, printing of Government documents, Immigration and Registration of Persons, Betting Control Probation Services, Prison Services and championing campaign against drug and substance abuse.	Security is an extremely important aspect that the Nuclear Power Programme will have to address
Ministry of Environment and Forestry	• This Ministry is responsible for policies and programmes aimed at improving, maintaining, protecting, conserving and managing the Country's natural resources (water, forestry, wildlife and	The Nuclear Power Programme will have to align with the policies and programmes of this Ministry

National Institutions	Responsibility	Relevance to the KNNP
	environment). It is also responsible for ensuring access to clean, safe, adequate and reliable water supply.	
Ministry of Water and Irrigation	• The Ministry of Water and Irrigation (MWI) mission statement is to contribute to national development by promoting and supporting integrated water resource management to enhance water availability and accessibility. The MWI has the following technical departments: Water Services, Water Resources, Water Storage and Land Reclamation, and Irrigation and Drainage.	NPP will require water for nuclear reactors and will have to engage with MOWI
Ministry of Devolution and Planning	• This Ministry includes the Department of Devolution as well as the Department of Planning that national development planning and economic policy management	The Nuclear Power Programme will have to align with the policies and programmes of this Ministry, with specific regard to the Department of Devolution
National Environment Management Authority (NEMA)	• The responsibility of NEMA is to exercise general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of Government in the implementation of all policies relating to the Environment.	Regulation and licensing of the SESA and subsequent licensing of programme components
Kenya Maritime Authority	• A semi-autonomous agency in charge of regulatory oversight over the Kenyan maritime industry	The registration of any ships and vessels within the NEC
Kenya Marine and Fisheries Research Institutes (KEMFRI)	• Undertake research in marine and freshwater fisheries, aquaculture, environmental and ecological studies, and marine research including chemical and physical oceanography	The Nuclear Power Programme should be in consultation with the Institute in order to protect the any endangered species at the Coast of Mombasa during implementation of projects as part of the Nuclear Power Programme.
Water Resources Management Authority (WRMA)	• WRMA is the lead agency in nationwide water resources management.	Wetlands and water resources located along the proposed sites for the Nuclear Power plants are protected. If some development works are planned to be conducted inside of those wetlands or water to be abstracted for use, a special permit shall be obtained from WRMA.
Kenya Wildlife Service (KWS)	• Protection and management of Wildlife in Kenya	The Nuclear Power Programme implementation should be in consultation with the institution in strategizing sustainable ways of development along the NPP
Kenya Forest Services (KFS)	• Protection and management of Forests and Reserves in Kenya	KFS will be responsible for guiding the development within forests and reserves under the NPP

	National Institutions	Responsibility	Relevance to the KNNP
	The Nuclear Power and Energy Agency Board	• Fast-tracking the development of nuclear power in order to enhance the production of affordable and reliable electricity	NuPEA is the owner of the KNPP
	Energy and Petroleum Regulatory Authority (EPRA)	• Regulates all energy subsectors and protects interest of stakeholders ensuring reasonable return on investment for developers/utilities, licensing, approves PPAs between KPLC and power generators; reviews and adjusts tariffs for consumers and IPPs	NPP will need approvals from EPRA
	County Government	• Responsible for energy planning and development within their jurisdiction. In charge of electricity and gas reticulation and energy regulation	County Governments play a role in energy issues
3	The Energy Petroleum Tribunal	• Responsible for arbitration of disputes between EPRA and aggrieved stakeholders in the energy sector	Tribunal will resolve conflicts and disputes between stakeholders in nuclear energy sector
	Rural Electrification and Renewable Energy Corporation	• Implement rural electrification through grid extension and off-grid systems such as solar and mini-hydro. • REREC administers and manages the Rural Electrification Fund (REF); mobilizes funds to support rural electrification, finances project preparation studies for rural electrification and recommends to government suitable policies.	Nuclear energy may be evacuated to REREC's grid and network
	Kenya Electricity Generating Company (KenGen)	• Develops and manages all public power generation facilities in the country (large and small hydro, geothermal, diesel-grid connected or off-grid)	
	Kenya Power & Lighting Company (KPLC)	• Public company that transmits, distributes and retails electricity to customers in Kenya	After step-downs the power will need to distributed to the end-user: homes, schools, factories etc.
	Kenya Electricity Transmission Company (KETRACO)	• Plans, designs, builds and maintains electricity transmission lines and associated substations	Nuclear energy may be evacuated to KETRACO's grid and network
	Kenya Nuclear Regulatory Authority	•	

4.9 Policy, Legislative and Regulatory Progress in Kenya

4.9.1 Policies and Strategies

4.9.1.1 Kenya National Nuclear Fuel Cycle Policy and Strategy, 2017

This policy and strategy is to address national priorities and objectives for Kenya's choice for an optimum nuclear fuel cycle. It also is to address the potential long-term strategies for a sustainable front-end and back-end solution. This will entail views from all relevant stakeholder inputs from different industrial sectors of the country. At this point, it should be noted that, due to the risk of

proliferation, uranium enrichment and reprocessing constitute a technical as well as a political problem (KNEB, 2017).

4.9.1.2 National Policy and Strategy for Safety for Kenya, 2015

This policy and strategy presents a fundamental political orientation, commitment to nuclear, and radiation safety as an overriding priority in all aspects of the use of nuclear technology, nuclear material and/or ionizing radiation sources, and generators. This policy and strategy document describes the fundamental safety objective and the ten safety principles as defined by the IAEA (IAEA, 2006). Further, it describes the main radiation and nuclear practices/activities in Kenya; human and financial resources needed for nuclear safety; nuclear research and development for safety; spent fuel and radioactive waste safety; legal, regulatory and institutional framework, international cooperation (global nuclear safety regime), emergency preparedness and response and civil nuclear liability and risks, consequences and mitigation measures in nuclear safety (KNEB, 2015). The Policy will ensure measures are in place to:

- To control the radiation exposure of people and the release of radioactive material to the environment;
- To restrict the likelihood of events that might lead to a loss of control over a nuclear installation, radioactive source or any other source of radiation;
- To mitigate the consequences of such events (in b) if they were to occur.

4.9.1.3 National Policy and Strategy for Radioactive Waste Management, 2017

This is a national policy and strategy for managing spent fuel and/or radioactive waste. It sets out the nationally agreed position and/or plan for managing spent fuel and radioactive waste. In addition, it is a visible evidence of the concern and intent of the government and the relevant national organizations to ensure that spent fuel and radioactive waste are properly taken care of. Formulation of a national policy and strategy is particularly vital in countries introducing nuclear power (KNEB, 2017).

4.9.1.4 Nuclear Regulatory Act, 2019

The Act repealed the Radiation Protection Act (Cap. 243) and provides for a comprehensive regulatory framework for radiation and nuclear safety, nuclear security and safeguard to control radiation sources, nuclear materials and associated wastes. The Act aims to protect the people, property and the environment from harmful effects of exposure to radiation and to provide for nuclear safety and non-proliferation in accordance with national and international obligations (GoK, 2019).

Table 4-3: Key provisions in the Nuclear Regulatory Act, 2019

Bill Part	Clause	Proposed Provisions	Key Provisions
Part I	**Clause 1-5**	*Provides for the interpretation; objective and purpose; and application of the Act.*	**Clause 3 (Purpose of the Act)** • Regulate the safe, secure and peaceful development, production, possession, use, storage, transport, transfer, disposal or handling of nuclear and radioactive materials, activities and facilities and other apparatus generating ionizing radiation; • Protect persons, property and the environment in relation to nuclear and radioactive material, activities and facilities and other apparatus generating ionizing radiation.
Part II	Clause 5-15	*Establishes the Kenya Nuclear Regulatory Authority* *Gives provisions on the powers of the authority* *Gives composition of the authority*	**Clause 6 (Functions of the authority)** • Ensure the safe, secure and peaceful use of nuclear science and technology; • Provide for the protection of persons, property and the environment against the harmful effects of ionizing radiation through the establishment of a system of regulatory control; • Exercise regulatory control over –(i) sitting, design construction, operation, manufacture of component parts and decommissioning of facilities; (ii) nuclear and radioactive materials and facilities; (iii) any other activities which the Authority may seek to exercise regulatory control over; • Ensure compliance with the conditions of authorization through the implementation of a system of inspections and enforcement; • Co-ordinate the fulfilment of national obligations in respect of nuclear safety, security and safeguards; • Co-operate with any relevant international agency by providing any assistance or information required; • Establish appropriate awareness methods and procedures for informing and consulting the public and other interested parties about the regulatory process and the safety, health and environmental aspect of regulated activities including incidents, accidents and abnormal occurrences;
Part III	Clause 19-20	*States the proposed financial provisions of the Act*	N/A
Part IV	Clause 21-31	*Gives provisions for Regulatory control: not notifications, authorizations, inspections and enforcement*	**Clause 22** • A person shall not carry out an activity unless the activity has been: (a) specifically authorized by the Authority; or (b) exempted, wholly or partially from regulatory control, by the Authority.

Bill Part	Clause	Proposed Provisions	Key Provisions
Part V	Clause 32-36	*Radiation protection*	**Clause 32** (1) (Radiation control for radiation protection) • Gives the conditions that must be fulfilled for issuance of license **Clause 32 (2)** • Gives exemption conditions for criteria for issuance of license **Clause 36** Gives provisions for intended radiological exposures with transboundary effects
Part VI	Clause 37-42	*Safety of radiation sources and facilities*	**Clause 37-38** • The Authority shall establish a system of control over radiation sources to ensure they are safely managed and securely protected during and at the end of their useful lives; and prescribe a categorization of sources based on the sources based on the potential injury to people and the environment. • Primary responsibility for ensuring the safe and secure use of radiation sources rests with the licensee • C39: Gives provisions for a national register of radiation sources • C40: Gives provision for prompt reporting of loss of radiation source to the Authority
Part VII	Clause 43-51	*Safety of nuclear facilities and decommissioning*	• Clause 43 includes Nuclear Power Plants as part of the of the Nuclear activities that require authorization by the Authority on matters including but not limited to nuclear facility design; siting; construction; commissioning; operation; and decommissioning; and • Remediation. • C44 vests responsibility of safety of facility unto the facility's owner (the authorized person) • C45 provides for the conditions to be met when undertaking a site evaluation report for a nuclear activity while C46 gives criteria for review of site evaluation report by the Authority to guide in invoking decision on authorization. • C48 gives provisions on requirements for decommissioning plan of nuclear activities to be considered by the Authority. • C49 indicates the following decommissioning responsibilities as bestowed to the authorized person - Ensuring safety, security and environmental protection, including any activities conducted by contractors or subcontractors; - Preparing the safety and environmental impact assessments necessary for implementation of the decommissioning plan;

Bill Part	Clause	Proposed Provisions	Key Provisions
			- Establishing a record keeping system of the key issues and modifications during the lifetime of the facility that may have an impact on decommissioning; - Ensuring that the baseline survey of the site is performed in an effective and timely manner; - Ensuring that new or untried methods for decommissioning are justified, addressed and submitted for approval by the Authority; - Informing the Authority within two months of a decision to permanently shut down a facility and submitting an application to decommission the facility, together with a proposed final decommissioning plan, within two years of permanent cessation of operation; - In the case of deferred dismantling, ensuring that the facility has been placed and will be maintained in a safe configuration and will be adequately decommissioned in the future; - Establishing and maintaining a management organization and personnel resources to ensure that decommissioning can be completed safely, including ensuring that responsible persons possess the necessary skills, expertise and training for safe decommissioning; - Establishing and maintaining emergency planning arrangements commensurate with the associated hazards and reporting significant incidents to the Authority; and
			- Ensuring that adequate financial arrangements are made for all stages of the decommissioning process. • C51 gives provisions for financing of decommissioning of nuclear facilities.
Part IX	Clause 57-62	*Emergency preparedness and response*	• C57 indicates that the Authority shall work with a national body in charge of national emergency preparedness to (a) define the criteria for classification of emergencies;(b) review and approve emergency preparedness and response plans developed by the licensee; (c) • advise and provide technical support on radiological emergencies and nuclear accidents. • C58-59 indicates that preparation of an emergency preparedness and response plan is a precursor to authorization of a nuclear activity and shall include both on-site and off-site plans. The plans are subject to periodical reviews by the Authority. • C61 gives provisions for cases of transboundary impacts of a nuclear activity which include notification of the International Atomic Energy Agency

Bill Part	Clause	Proposed Provisions	Key Provisions
			and the relevant authorities of any State which is or may be physically affected by a release that could be of a radiological nature. • C62 provides for regular informing of the public about the significant facts about emergency preparedness and response by the licensed authority.
Part X	Clause 63-68	*Transportation of nuclear material*	• C63 gives mandate to the Authority to develop regulations on transport of nuclear material to protect persons and environment; meet national and international obligations; support international cooperation in the safe, secure and peaceful uses of nuclear science and technology; and support international efforts to prevent the proliferation of nuclear weapons, explosive and radiological dispersal devices. • C66 obliges all nuclear material carriers to develop Radiation Protection Transport Plan taking into account: • The nature and extent of the measures to be taken in respect of the likelihood and magnitude of radiation exposures or environmental contamination; • Adopt a structured and systematic approach including consideration of the interfaces between the mode of transport and other activities. • C68 provides for segregation of material as per consignment to avoid contamination.
Part XI	Clause 69-72	*Export and Import Controls*	• C69: the part ensures that there are laid controls on exporting and importing of nuclear material.
Part XII	Clause 73-82	*Radioactive waste and spent fuel management*	• C73 gives scope and principles for radioactive waste management and spent fuel management • C74 gives primary responsibility upon the authorized person for the safety and security of radioactive waste and spent fuel management inside or outside throughout its life encompassing; - Generation of the activity and volume of radioactive waste is kept to the minimum practicable level by suitable design, operation and decommissioning of its facilities; - Radioactive waste is managed by appropriate classification, segregation, treatment, conditioning, storage or disposal, and maintaining records of such activities; - Management of radioactive waste is not unnecessarily delayed; - Information sought by the, Authority is furnished as requested. • C75 provides for classification of radioactive waste for safe management while C76 obliges the authorized person to submit a radioactive waste management plan to the Authority as prescribed by the proposed Act.

Bill Part	Clause	Proposed Provisions	Key Provisions
			• C78 gives provisions for collection, segregation and characterization of radioactive waste while, C79 gives provisions for discharge of radioactive waste to the environment unless: such discharge is within the limits specified in the authorization and is carried out in a controlled manner using authorized methods; or the activity discharged is confirmed to be below clearance level. • C80 gives provisions on authorization to operate a radioactive waste and spent fuel management facility. • C81 prohibits importation of radioactive waste and spent fuel into the country but C82 gives room for exportation upon authorization by the Authority.
Part XIII	Clause 83-88	*Safeguards*	• Gives provision for peaceful uses of the nuclear materials, facilities and activities in Kenya
Part XIV	Clause 89-94	*Nuclear security and physical protection*	• C89 provides for Authority's coordination with the national security institutions to ensure security measures have been put in place. • C90 gives mandate to the authorized person as primarily responsible for ensuring the physical protection of nuclear material, radioactive material and related facilities under its control • C91 in case of any event of an unlawful taking or threat of International unlawful taking of nuclear material, the Authority shall take appropriate steps as soon as possible to inform other States that may be affected of the circumstances of the incident and the relevant international entity.

Source: (Nuclear Regulatory Act, 2019)

4.10 International Frameworks

Currently, there are several conventions in the area of nuclear, radiation, transport and waste Safety:

4.10.1 Convention on Nuclear Safety

Commits Participating States operating land-based nuclear power plants to maintain a high level of safety by setting international benchmarks to which States would subscribe.

4.10.2 Convention on the Physical Protection of Nuclear Material (CPNM)

Obliges Contracting States to ensure during international nuclear transport the protection of nuclear material within their territory or on board their ships or aircraft.

4.10.3 Amendment to the Convention on the Physical Protection of Nuclear Material

Parties to the CPPNM adopted by consensus an amendment to the CPPNM. Whereas the obligations for physical protection under the CPPNM covered nuclear material during international transport, the Amendment to the CPPNM makes it legally binding for States Parties to protect nuclear facilities and material in peaceful domestic use, storage and transport. It also provides for expanded cooperation between and among States regarding rapid measures to locate and recover stolen or smuggled nuclear material, mitigate any radiological consequences of sabotage, and prevent and combat related offences.

4.10.4 Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency

Sets out an international framework for co-operation among Parties and with the IAEA to facilitate prompt assistance and support in the event of nuclear accidents or radiological emergencies.

4.10.5 Convention on Early Notification of a Nuclear Accident or Radiological Emergency

Establishes a notification system for nuclear accidents that have the potential for international transboundary release that could be of radiological safety significance for another State.

4.10.6 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

It is a legally binding international treaty on safety in this area of management of radioactive waste and spent fuel. It represents a commitment by participating States to achieve and maintain a consistently high level of safety in the management of spent fuel and of radioactive waste as part of a global safety regime for ensuring the proper protection of people and the environment.

4.10.7 Civil Liability for Nuclear Damage

Recent events in the nuclear field and particularly the Fukushima Accident has necessitated the need for consideration of nuclear liability treaties as an integral part of the international nuclear law regime.

- The following treaties on civil liability for nuclear damage:
- The 1963 Vienna Convention on Civil Liability for Nuclear Damage;
- The 1997 Protocol to Amend the Vienna convention on Civil Liability for Nuclear Damage; and
- The Joint Protocol relating to the Application of the Vienna Convention and the Paris Convention.

4.11 Non-Binding International Instruments

Code of Conduct on the Safety and Security of Radioactive Sources and Code of Conduct on the Safety of Research Reactors are non-binding international instruments developed by the IAEA with the participation of the relevant stakeholders. They have come to be globally acknowledged as “acceptable” additional conditions for nuclear safety and security.

Despite that fact that there are no sanctionable legal measures that can be meted out on a non-complying State, the international nuclear community has developed an ingenious way to ensure compliance with them – strictly dealing only with States that have expressed political commitment to the Codes of Conduct. This is usually done through formally writing to the Director General of the IAEA to the Codes of Conduct.

Code of Conduct on the Safety and Security of Radioactive Sources, seeks to establish a framework for national authorities to ensure that radioactive sources are used within an appropriate framework of radiation safety and security whilst Code of Conduct on the Safety of Research Reactors, developed and regularly updated by the International Safety Advisory Group (INSAG) and the views of other relevant bodies, provides for an international nuclear safety framework for civil research reactors.

4.12 Other Relevant International Instruments

Besides the aforementioned treaties and conventions under the auspices of the IAEA, there also exists an international regime for Non-Proliferation of nuclear weapons with varied repositories including the United Nations, USA, Russia, and UK.

4.12.1 The Comprehensive Nuclear-Test-Ban Treaty (CTBT)

It’s a legally binding global ban on nuclear explosive testing. The CTBT was opened for signature in 1996.

4.12.2 The Treaty on the Non-Proliferation of Nuclear Weapons (NPT)

The Treaty represents the only binding commitment in a multilateral treaty to the goal of disarmament by the nuclear-weapon States. A total of 190 parties have joined the Treaty, including the five nuclear-weapon States.

The NPT seeks to achieve its mandate by establishing Nuclear-Weapon-Free Zones (NWFZ) - a regional approach to strengthen global nuclear non-proliferation and disarmament norms and consolidate international efforts towards peace and security.

The following treaties form the basis for the existing NWFZs:

- Treaty of Tlatelolco - Latin America and the Caribbean Nuclear Free Zone Treaty;
- Treaty of Rarotonga - South Pacific Nuclear Free Zone Treaty;
- Treaty of Bangkok - Treaty on the Southeast Asia Nuclear Weapon-Free Zone; and
- Treaty of Pelindaba - African Nuclear-Weapon-Free Zone Treaty

Other treaties that deal with the denuclearization of certain areas include:

- Outer Space Treaty - Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies
- Moon Agreement - Agreement Governing the Activities of States on the Moon and Other Celestial Bodies
- Seabed Treaty - Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil Thereof.
- UN Security Council Resolutions decisions are formal expressions of the opinion or will of the Council. In general, resolutions adopted by the Council acting under Chapter VII of the Charter, are considered binding, in accordance with Article 25 of the Charter. Below are some of the resolutions that directly touching on nuclear security and safety.

Resolution 1373 (28th September 2001)

The resolution calls for UN member states to work together to suppress terrorist financing, share intelligence on terrorism, monitor borders, and implement the relevant international conventions and protocols to combat terrorism.

Resolution 1540 (28th April 2004)

The resolution obliges States, inter alia, to refrain from supporting by any means non-State actors from developing, acquiring, manufacturing, possessing, transporting, transferring or using nuclear, chemical or biological weapons and their delivery systems.

Resolution 1887 – (24th September 2009)

With this resolution, the Council seeks "a safer world for all and to create the conditions for a world without nuclear weapons in accordance with the goals of the (NPT), in a way that promotes international stability, and based on the principle of undiminished security for all." It calls on all countries to adhere to their obligations under the NPT, including co-operation with the IAEA and for States to establish measures to reduce nuclear arms.

Table 4-4: International Obligation Status for Kenya

No.	Convention/Treaty	Status
1.	Convention on Nuclear Safety	Not a party
2.	Convention on Early Notification of a Nuclear Accident	Not a party
3.	Convention on Assistance in the Case of a Nuclear or Radiological Emergency	Not a party
4.	Joint Convention on the Safety of Spent Fuel Management and of the Safety of Radioactive Material	Not a party
5.	Convention on Physical Protection of Nuclear Material	Ratified

No.	Convention/Treaty	Status
6.	Amendment to the Convention on the Physical Protection of Nuclear Material	Accepted on 1st August 2007 but not ratified
7.	Agreement on the Privileges and Immunities of the IAEA	Not signed
8.	Treaty on Non-Proliferation of Nuclear Weapons	Ratified 18.09.2009
9.	IAEA Comprehensive Safeguards Agreement IAEA Additional Protocol	Signed 18.09.2009
10.	Comprehensive Test Ban Treaty	Ratified 06.10.1965
11.	Nuclear Weapons Free Zone Treaty (Pelindaba Treaty)	Party 15.11.2000
12.	Chemical Weapons Convention	Signed - Jan 1993 Ratified April 1997
13.	Biological Weapons Convention	Ratified - July 1976
14.	International Convention for Suppression of Acts of Nuclear Terrorism	Ratified
15.	International Convention on Suppression of Terrorist Bombing	Ratified
16.	International Convention for the Suppression of Financing or Terrorism	Ratified
17.	International Code of Conduct against Ballistic Missile	Signatory
18.	Zangger Committee[3]	No Political Commitment
19.	Security Council Resolutions 1373/2001, 1540/2004, 1887/2009	Binding in accordance with Article 25 of the UN Charter

4.13 Non-Nuclear Conventions

Table 4-5: International Conventions (Multi-lateral Environmental Agreements)

Convention	Date Ratified/Acceded to
African Convention for the Conservation of Nature and Natural Resources (2003)	Ratified (12 May 1969)
Convention on Biological Diversity (1992)	Ratified (26 July 1994)
Ramsar Convention	
CMS	
Paris Agreement	
Vienna Convention for the Protection of the Ozone Layer (1985)	Acceded to (9 November 1988)
UNESCO Convention for the Protection of the World Cultural and Natural Heritage (1972)	Acceded to (1 May 1964)
Convention on the Conservation of Migratory Species of Wild Animals (1985) The African-Eurasian Water-bird Agreement (AEWA). The Agreement on the Conservation of African-Eurasian Migratory Water birds (AEWA).	Acceded to (26 February 1999)

Convention	Date Ratified/Acceded to
Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)	Acceded to (13 December 1978)
Convention on Persistent Organic Pollutants (2001)	Ratified (24 September 2004)
Basel Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal (1995)	Acceded to (1 June 2000)
Bamako Convention on the Ban of the Import into Africa and the Control of Trans-Boundary Movement and Management of Hazardous Wastes within Africa (1991)	Only signatory
Convention on Climatic Change and the Kyoto Protocol (1997)	Ratified (25 February 2005)
Lusaka Agreement on the Cooperative Enforcement Operations Directed against Illegal trade in Fauna (1994)	Ratified (17 January 1997)
Nile Basin Initiative (1999)	19th May 2010

4.14 Gaps in the Existing Policy, Institutional and Legislative Framework

The following Policy, legal, regulatory and institutional gaps were identified: -

- **IAEA in its guiding publication on Environmental Management indicates that most EIA/ Audit regulations:** (IAEA Series No: NG-T-3.11: - Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes), (IAEA, 2014), indicates that most countries legal structure on EIA does not meet the international requirement development of nuclear programme and therefore require a few additions to ensure this is achieved. Nuclear facilities are unique and complex especially on their societal acceptance, safety and decommissioning which ought to be guided by a robust legal framework. Additionally, EIAs or nuclear plants are expected to take more time to undertake review and approve compared to other industrial developments. Finally, the capacity to adequately review Nuclear-related EIAs is very low at NEMA hence need to train a specialized desk of staff for the same.

- **Environmental Management and Coordination (Water Quality) Regulations, 2006** only mentions of prohibition to release radioactive waste into water resources but needs to be expounded further incorporating the future scenarios with introduction of the Nuclear Power Programme and the need for water for reactor cooling, treatment and disposal of radioactive.

- **Environmental Management and Coordination (Waste Management) Regulations, 2006** do not meet the purpose NPP operation in the management of Used Nuclear Fuel Management and Radioactive Waste Management, hence there is need to review the regulation in order to incorporate clauses and instil responsibility for radioactive waste management, including handling, transport, treatment and disposal. The capacity to advise and oversight management of radioactive waste is very low at NEMA hence need to train a specialized desk of staff for the same.

- ***Environmental Management and Coordination (Air Quality) Regulations, 2014***-no give provision on air contamination by radioactive material.

- ***Strategic Environmental and Social Assessment (SESA) guidelines and comprehensive regulations****:* The existing 2012 Guidelines require public and stakeholder participation in order to improve on SESA resource requirements (human, financial and technical), procedures, standards and timelines. SESA regulations that shall indicate SESA detailed procedures, fees to be paid by PPP owners, specific penalties, etc. are currently not ready.

- ***Social Impact Assessment (SIA) Guidelines:*** SIA involves the analysis, monitoring and managing the social consequences of development strategies/ policies, plans, programmes and projects. Social issues that need to be emphasized in the existing EIA/EA regulations include assessment of impacts on people's way of life, culture and traditions, community, political systems, health and wellbeing, property rights, fears and aspirations. Currently, there exists a policy gap on information required during the EIA process on potential, sociocultural, gender-specific impacts and opportunities of the nuclear energy sector – including how men, women, youths and children who may experience risks and benefits from the sector.

- ***Decommissioning of Facilities and Restoration:*** Section 93 of the EMCA, Cap 387 prohibits discharge of hazardous substances, chemicals and materials or oil into the environment and outlines basic guidelines on the spiller's liability. However, there exists no specific legislation envisaged in this section to handle nuclear facilities. The "*polluter-pays-principle"* hangs in law with no specific guidelines' manual on assessment of environmental damages.

- ***Eviction and Resettlement Legal Guidelines:*** To deal with land acquisition and social impacts, there is need for finalizing the existing drafts to ensure high environmental and social performance standards for this sector in public, private and community land. The guidelines should outline grievance redressed mechanisms for the conflict resolution during resettlement action planning. There should be guidelines to communities especially in the candidate areas where fishing is a key on their compensation. In the event that nuclear programme activities interfere with their access to the fishing activities, there should be clear guidelines on how the fishermen should be compensated and their communities developed.

- ***Environmental Quality Standards for Nuclear Sector:*** There is lack of environmental standards and guidelines for nuclear power programme activities to meet international environmental quality thresholds.

- ***Institutional and organizational Set-ups:*** There is no specific department or section in Kenya's National Environmental Management Authority (NEMA) clearly designated to handle the Nuclear Programme environmental, health and safety issues and implementation of emergency response programmes for the sector in case of an emergency. NEMA also has a very limited capacity on nuclear issues and engineering hence unable to undertake technical review of EIA reports from the sector and provide the advice expected by the sector.

- ***Development of an Environmental Management and Information System (EMIS):*** NEMA has not developed this system to the expected levels due to limited resources. EMIS provides a complete, largely automatic, fully integrated, state-of-the-art ICT solution for the environmental management: planning, assessment, compliance monitoring and impact assessment as well as emergency management. This will provide NEMA and other lead agencies with an information technology solution for tracking environmental data for the emerging nuclear sector as part of their overall Environmental Management Systems (EMS). Currently, the process of designing EMIS has commenced and is expected to overcome this gap.

- ***National Environmental Monitoring Laboratory:*** This facility is in place but needs to be upgraded to take a leading role in a broad range of specialized and internationally accredited analytical laboratory services, including radiation monitoring and analysis.

- ***Environmental Provisions in Nuclear Power Programme:*** The Nuclear Regulatory Act, 2019 proposes undertaking of Environmental Assessments before development and

decommissioning of nuclear facilities. When the Bill is enacted and in operation, it will be necessary to directly connect with EMCA, Cap 387 through formulation of guidelines and regulations by providing detailed procedures of undertaking of Nuclear sector EIAs prior to project commencement, Environmental monitoring during Project (s) construction and undertaking of annual environmental audits as required by the Act. Environmental monitoring, compliance and enforcement are likely to face challenges due to limited financial and technical capacity of NEMA, County Governments and other relevant Government Agencies like DOSHS, Kenya Forest Service (KFS), Kenya Maritime Authority (KMA), National Land Commission (NLC) Water resources Authority (WRA) and Kenya Wildlife Service (KWS).

- ***Access to Land for Nuclear Power Programme****:* The land tenure system in Lake Turkana Basin and Lower Tana Basin is communal. Thus, land is collectively owned by the residents and managed, on behalf of the community, by the County Governments. Land adjudication to various communities/ clans is yet to be undertaken in most areas, thus pasture and settlement lands have no legal land ownership documents. This has been the main cause of boundary-related conflicts and inter-tribal and inter-clan clashes especially in the Tana Delta area.

  The Nuclear Energy Regulatory Bill should provide that whenever, in the course of carrying out nuclear activities, any disturbance of the rights of the owner or occupier of private land, or damage to the land, or to any crops, trees, buildings, stock or works therein or thereon is caused, the NPP owner shall be liable on demand to pay to the owner or occupier such compensation as is fair and reasonable having regard to the extent of the disturbance or damage and to the interest of the owner or occupier in the land. This Act does not give guidelines on access to public and community lands in terms of compensation to the Government or County Governments.

- ***Sharing of Nuclear Opportunities for Community Economic Empowerment:*** Project-related conflicts have been experienced in Kenya in the past due skewed opportunity sharing, especially available skilled, semi-skilled and un-skilled job opportunities and relevant good and services (for example, transport, security, supply of goods, etc.).

  The Community Land Act, 2016 requires that every investor on community land shall spend not less than forty percent (40%) of the net income in any or some of the following: (a) provision of services to the community; (b) laying infrastructure in the community; (c) education and capacity building; or (d) payment of royalties. There is need to make this provision in Nuclear Regulatory Act, 2019 in case of areas where the Community Land Act, 2016 becomes relevant.

- ***Institutional and Organizational Set-ups:*** There is no specific department or section in Kenya's National Environmental Management Authority (NEMA) with capacity to handle nuclear-related environmental, health and safety issues and implementation of emergency response programmes for the nuclear sector in case of an emergency. NEMA also has limited staff nuclear technology issues who are able to undertake technical review of EIA reports from the sector and provide the advice expected by NPP contractor and operator(s).

- ***Environmental Due Diligence***: Environmental Due Diligence (EDD) is an increasingly international important part of the corporate due diligence process. Environmental liabilities can be large and hidden, and there are many examples of purchasers and funders being hit with unforeseen costs. The current laws do not mention this requirement and even sharing of the final report with NEMA for approval or advisory purposes.

- ***Occupational Health and Safety Policy, Legal, Institutional Gaps***
  - There are no policy guidelines on: governing formulation of OSH Policies by players in the Nuclear Sector
  - There are no policy guidelines relating to needs analysis and capacity building in the institution bestowed with the responsibility of implementing the provisions of OSHA, 2007 (DOSHS)
  - There are no policy guidelines in the relevant codes of practice for OSH Auditing and OSH performance monitoring in the nuclear energy sector
  - There are no policy guidelines on appropriate hazard control interventions including but not limited to appropriate PPEs to be used in the Nuclear energy sector
  - There are no policy guidelines on needs analysis and capacity building to the OSH experts and other stake holders obligated to give OSH advisory support to the nuclear energy sector
  - There are no policy guidelines on Emergency Response and Evacuation Plans in the nuclear energy sector
  - OSHA, 2007 does not cover Community Health and Safety
  - The Factories (Fire Risk Reduction) Rules, 2007 in their formulation, envisages small workplace fires and have not adequately given legal guidelines on fires of the magnitude envisaged in the nuclear energy sector
  - The Factories (First Aid) Rules, 1977 are too general and do not adequately cover injuries of the magnitude envisaged in the nuclear energy sector considering the intrinsic nature of the sector
  - DOSHS has inadequate infrastructural, competence and operational capacity to implement and enforce OSHA, 2007 in the nuclear energy sector
  - There are cross institutional mandates overlap. There are some mandates that put DOSHS, NEMA and Public Health in conflict, e.g., noise, medical examinations, pollution, etc. Furthermore, the proposed Nuclear Energy Regulatory body will put into conflict some of the mandates bestowed upon the aforementioned institutions.
  - OSHA, 2007 and its subsidiary legislations do not adequately cover Transport Safety in nuclear energy sector

Finally, NuPEA has developed National Nuclear Policy and Strategy for Safety for Kenya but the document does not show what would the position of the Directorate of Occupational Health and Safety Services be in NPP operation nor does it indicate whether any due consultations were done with the directorate.

- ***Integrated EIA Approach:*** All EIA reports reviewed had not taken into consideration an integrated approach to Environmental Impact Assessment. The Code of Practice and Professional Ethics for Integrated Environmental Assessment and Audit Experts in Kenya expects them to apply an integrated approach since this Code defines “Integrated Environmental Assessments” to include Environmental Impact Assessment, Archaeological Impact Assessment (AIA), Social Impact Assessment (SIA), Health Impact Assessment and Cultural Impact Assessments (CIA). However, most EIA experts ignore this because either they have no capacity or most project components find it expensive or due to land of legal requirement on the same. The HIA is a means of assessing the health impacts of policies, plans, programmes and projects in diverse economic sectors using quantitative, qualitative and participatory techniques. HIA helps decision-makers make choices about alternatives and improvements to prevent disease/injury and to actively promote health, which is one of the goals of sustainable development. The World Health Organisation (WHO) supports in the development of tools and initiatives in HIA to dynamically improve health and well-being across sectors. A well-executed HIA can prevent new project delays by anticipating, soliciting

and appropriately incorporating stakeholder concerns and suggestions into the overall project design. Similarly, existing operations can also benefit by the timely assessment and evaluation of a broad range of impacts. One of the key benefits of the HIA process for stakeholders is the awareness that health is a relevant and significant cross-cutting issue.

- ***Quality and Standard of Environmental Impact Assessment (EIA) and Audits:*** The general quality of Environmental Impact Assessment process and reports in Kenya by reviewing EIA reports is wanting (Oil and Gas SESA, 2017). There is a general deficiency in the EIAs and EMPS which include:
  - Lack of adequate training among most EIA experts in the country sector-specific reporting. Most reports for such sensitive sectors do not meet the international requirements and standards.
  - Inadequate technical skills and manpower at NEMA and lead agencies in reviewing EIA and audit reports.
  - Disclosure of EIA and Audit reports and final decisions/ licence conditions to the directly affected persons/ local communities
  - Limited public participation in the whole EIA and audit processes
  - No clear guidelines on whom at NEMA should project reports should be submitted to, reviewed and licenced. Currently, some are projects for high impact projects are licenced at counties and NEMA head office. Due to the high impacts from such projects, they are supposed to be handled by the head office due to limited capacities at the counties
  - Counties have not established County Environment Committees. Hence, reports are approved by the County Director of Environment

Gaps due to the absence of a Nuclear Energy Regulatory Body

- ***Nuclear Sector EIA/EA Technical Manual Guidelines****.* Since the National Position on Nuclear Energy was declared by the government and absence of a nuclear energy regulatory body, the country lacks Technical Manual Guidelines localized to the national context from the international guidelines as provided by IAEA. Such manuals would be pivotal for improving and ensuring national NPP acceptability.

- ***Nuclear Sector Environment, Health, Safety (EHS) Guidelines*****:** These guidelines do not exist leaving a major gap in the sector, which is associated with high risks associated with the oil, and gas facilities work environment.

- ***Environment Liability Policy***: international standards on nuclear liability recommends on civil liability in case of any nuclear incident. Recommendations and provisions of such standards and international legal structures should be domesticated.

- ***Radioactive Waste Management Standards:*** NuPEA has developed a draft National Policy for Radioactive Waste Management. However, this from the onset sets a precedence against the international standards on independence of a regulator in legal and government infrastructure as accorded by IAEA, 2000 (IAEA Series No. GS-R-1). Policies and regulatory structures are best put in place by an independent regulator in order to minimize the risk on security and safety compromise from the NPP operator who shall be under the watch of the independent regulator.

5 CHAPTER FIVE: CONSULTATION AND PUBLIC PARTICIPATION

5.1 Introduction

Stakeholder Engagement and Public Participation process is an integral aspect of decision making in the SESA process for the purpose of achieving the fundamental principles of sustainable development. Public Participation and Consultation is a key policy requirement as stipulated in;

Article 10: The national values and principles of governance include -

a) patriotism, national unity, sharing and devolution of power, the rule of law, democracy and participation of the people;
b) human dignity, equity, social justice, inclusiveness, equality, human rights, non-discrimination and protection of the marginalized;
c) good governance, integrity, transparency and accountability; and
d) Sustainable development.

In addition, Article 69, Section 1 of the Constitution; Legal Notice 101 of the Environmental Management and Coordination, Cap 387; Section 3 of the EIA/EA regulations, 2003 and Section 87 & 113 of the County Governments Act, 2012 have provisions on public consultation and participation. It is an important process through which stakeholders including beneficiaries and members of the public living in project areas (both public and private), are given an opportunity to contribute to the overall project design by making recommendations and raising concerns on projects before they are implemented. In addition, the process creates a sense of responsibility, commitment and local ownership for smooth implementation.

This chapter describes the process of public consultation and participation that were followed to identify the key issues and impacts of Nuclear Power Plan.

5.2 Objectives of the Consultation and Public Participation

The objectives of the consultation and public participation are to:

(i) Disseminate and inform the stakeholders about the development with special reference to its key components and location
(ii) Create awareness among the public on the need for the SESA study for the Nuclear Power Programme
(iii) Gather comments, suggestions and concerns of interested and affected parties.
(iv) Incorporate all the information collected in the screening, scoping and SESA study for decision making process.

In addition, the process will enable:

(i) The establishment of a communication channel between the general public and the team of consultants, the proponent and the key government agencies.
(ii) The concerns of the stakeholders to be known to the concerned parties at an early phase of project development for decision-making purposes.

5.3 Stakeholder Engagement Plan

The main purpose of the stakeholder engagement plan (Table 5-1: Stakeholder Engagement Plan during the SESA Process) was to;

- Engage the stakeholders through consultative forums to analyse their interests, concerns and recommendations regarding the nuclear energy sector development

for incorporation into the SESA for effective regulation and management of the nuclear sectors.

- Secure and sustain support for the SESA process among key stakeholder groups.
- Create awareness and averting negative publicity on the nuclear sector.
- Improve NPP acceptability

Table 5-1: Stakeholder Engagement Plan during the SESA Process

Stakeholder Category/ organization, group or individual	Potential role in the SESA activity	Engagement strategy	Follow-up strategy plans for feedback or continued involvement
▪ ***Public Sector and Key Ministries/ Inter-ministerial Lead Agencies and Key Public Institutions***	▪ Formulate and implement nuclear sector policies, plans and programme ▪ To be responsible in implementation of SESA recommendations	▪ Invitation to participate in regional and national consultative meetings ▪ Special consultations at the organizational levels ▪ Case studies to specific projects/ programmes	▪ Invitation to National and regional SESA validation workshops ▪ Implement the final recommendations ▪ Participate in Monitoring and evaluation of the implementation of SESA recommendations
▪ ***Political Leadership***	▪ Political leaders have a great influence on the various policies, plans and programmes ▪ Play major role in creating awareness on government PPPs ▪ Understand energy politics	▪ Invitation of some political leaders to participate in regional and national consultative meetings ▪ Special consultations with the leaders from the candidate areas	▪ Invitation to National and regional SESA validation workshops ▪ Participate in formulation of laws to fill in the gaps identified by SESA process ▪ Incorporation of their views in the SESA report for implementation by the Government agencies.
▪ ***Professional Associations/ Experts/ Research and Academic Institutions***	▪ Lead in research and consultancy ▪ Undertake EIAs, SESAs and Environmental Audits	▪ Invitation to in regional and national consultative meetings.	▪ Invitation to National and regional SESA validation workshops ▪ Participate in Monitoring and evaluation of the implementation of SESA recommendations

Source: (SGS, 2019)

5.4 SESA Communication Strategy

A Communications Strategy was used as a tool to reach the various SESA stakeholders at the national and county levels. Communications strategy objectives were: -

- To educate and raise awareness concerning the SESA among all stakeholders using relevant media and languages (English, Swahili and local languages where it is necessary)
- Apply all means of communication to ensure full participation to the SESA process
- To continuously communicate adequate and useful information about SESA and its outputs to the stakeholders

Key target stakeholders in communication were those outlined in the engagement plan and these were divided into the following five (5) general categories: -

- Public Sector: Key Ministry Agencies and Lead Agencies, Key Public Institutions
- Private Sector Actors/ Investors / Associations
- Academic and Research Institutions
- Elected leaders/ politicians from oil potential areas (Northern and North Eastern Kenya)
- Civil Society Organisations (CSOs)

Messages delivered were tailored according to the target audience and region. Some of the messages include;

- Facts about the nuclear sector policies, plans and programmes
- General benefits of the SESA Process
- Specific benefits of the SESA process implementation to the national agencies, counties and communities for support and contribution towards meeting the basic goals of sustainable development of the sector.

5.5 Integrated Stakeholder Mapping

The stakeholders were mapped according to the stakeholder interest and influence in each area of nuclear key activities for each phase of the nuclear power programme. The government regulatory agencies responsible for governance aspects and have influence on sections of governance issues which is critical to certain phase of nuclear programme were eTable 5-3: Categorization of Relevant Stakeholders for the KNNP SESAngaged strategically. Security agencies for example have an interest in security matters weather physical or non-physical are engaged and involved according to the security needs of the nuclear power programme needs.

To ensure sustainable engagement/involvement, national & county government/ CSO/ regional governments/ private sector/ international bodies/ Site communities/ others are grouped according to the three areas of a) governance aspects of nuclear power development; b) Social Aspects of nuclear power development; c) environmental aspects of nuclear power development; Engagement planning are then listed according to prioritization for each phase of development, operations and decommissioning nuclear power plants. Table 5-3: Categorization of Relevant Stakeholders for the KNNP SESA shows the stakeholder categorization strategy used in the SESA. Table 5-3: Categorization of Relevant Stakeholders for the KNNP SESAcategorizes stakeholders according to their level of influence while Table 5-5: Statutory Involvement in decision making Categorizes the stakeholders according to their geographical location.

Table 5-2: Integrated stakeholder identification and mapping

Introduction of nuclear	Siting & Operations	Decommissioning of nuclear
High Interest & Low influence: ***Specialized information provided during all the phases of nuclear development, operations and decommissioning:*** a) Statutory; b) Non-Statutory - Government Regulators (national/County) - CSO (national/county) - Private Sector - Institutions	**High Interests & High Influence:** ***Partnerships developed for each phase of the nuclear development, operations and decommissioning:*** a) Statutory; b) Non-Statutory - Government Regulators (national/County) - CSO (national/county) - Private Sector - Institutions	
Lay language information is provided on nuclear power programme in all phases of interests/influence: a) Statutory; b) Non-Statutory - Government Regulators (national/County) - CSO (national/county) - Private Sector - Institutions	**Plan for Involvement of stakeholder with high influence but low interest during all the phases of nuclear power development, operations and decommissioning;** a) Statutory; b) Non-Statutory - Government Regulators (national/County) - CSO (national/county) - Private Sector - Institutions	

Source: (SGS, 2019)

a) Identification of statutory and non-statutory stakeholder with interest/influence on governance/social/economic/environmental/ aspects during Phase I of NPP;
b) Identification of statutory and non-statutory stakeholder with interest/influence on governance/social/economic/environmental/ aspects during Phase II of NPP;
c) Identification of statutory and non-statutory stakeholder with interest/influence on governance/social/economic/environmental/ aspects during Phase III of NPP;

Table 5-3: Categorization of Relevant Stakeholders for the KNNP SESA

	Statutory Stakeholders	Non-Statutory Stakeholders
High Interest/ High Influence	- IAEA - Ministry of Energy & Petroleum - Ministry of Environment; - Ministry of Water & Irrigation; - Ministry of Interior & Coordination of NG - Agencies include: ERC, Radiation Board, KENGEN, NEMA, KETRACO, NLC, WARMA, NSCC, Institute of Nuclear; - legislature at national and county levels -Private Sector banks, nuclear contractors and suppliers Governments	- national local and international CSO related to Energy, Water, Environment, - Universities and institutions of higher learning departments of energy, Water, Environments - County and regional specialist CSO's - National Faith based organisations (FBOs) - medical and health professionals - national media organisations
High interest/ Low influence	-Ministry Transport & Infrastructure -Ministry Lands; Ministry of Education -Ministry of Trade & EAC Agencies: Vision 2030; Kenya Power & Lighting; KEMFRI	- Private sector players and industry organisations - Potential Host Site County governments and stakeholders - states near sited locations
Low interest/ High Influence	-47 County Governments -Ministry of Mining - Ministry of Agriculture - Ministry of Industrialization & ED -Agencies: Communications Authority of Kenya; NMK; KEBS	Regional and county universities, and institutions of higher learning and research at the county level Interested in water, Environment, Energy etc. - Host county communities - Media organisations
Low interest/ Low influence	-Department of Mines & Geology -Regional Countries Governments of Uganda, Tanzania, S. Sudan, Ethiopia, Burundi and Rwanda;	- General national communities - Host County communities - environment and water agencies in regional countries

Source: (SGS, 2019)

Table 5-4: Identified stakeholders

	Statutory A (Ministries/Agencies and Institutions)		Statutory B	Non-Statutory A	Non-Statutory B
			Ministries/Agencies and Institutions		
Nairobi (UON) – Nairobi – Kajiado – Kiambu – Machakos	**Energy**	• Ministry of Energy and Petroleum • The Nuclear Power and Energy Agency • Kenya Electricity Transmission Company (KeTRACO) • Kenya Electricity Generating Company (KeGEN) • Energy Regulatory Commission (ERC) • Kenya Power & lighting Company (KPLC) • Rural Electrification and Renewable Energy (REREC) • The National Council of Governors • Kenya Investment Authority (KenInvest)	• Ministry of Devolution and Planning • Ministry of Labor & East Africa Affairs • Ministry of Industrialization and Enterprise Development • The Nuclear Power and Energy Agency • Vision 2030 Delivery Secretariat • County Governments of Nairobi, Kajiado, Kiambu and Machakos • the National and Senate Assembly committee on Energy and petroleum • The Kenya Revenue Authority (KRA)	• National and International CSO Environment & Energy • Institute of Nuclear Science & Technology (UON) • Department of Physics (JKUAT) • KEPSA • Kenya Renewable Energy Association (KEREA) • Kenya Association of Manufacturers • University of Nairobi • Jomo Kenyatta University of Agriculture and Technology • Kenyatta University	• International Energy Agency • UNDP • JICA • Independent Power Producers • China General Nuclear Power Corporation • ROSATOM Russia • Korea Electric Power Corporation • Korea Nuclear Association for International Cooperation
	Environment	• Ministry of Environment, and Natural Resource • Ministry of Mining • Ministry of Agriculture, Livestock and Fisheries • Kenya Meteorological Department	• National Environment Management Authority (NEMA) • Kenya Wildlife Services (KWS) • Kenya Forest Service (KFS) • Department of mines and geology • National Museums of Kenya	• National and International FBO on Environment and Natural Resources • Green Belt Movement • Environmental Institute of Kenya (EIK) • Institute for Law and Environmental Governance (ILEG)	• UNEP • Natural Justice • World Wide Fund for Nature • Global Environment Facility (GEF) • UNDP

	Statutory A (Ministries/Agencies and Institutions)		Statutory B	Non-Statutory A	Non-Statutory B
			Ministries/Agencies and Institutions		
			• County environmental Committees	• Community Action for Nature Conversation (CANCO) •	
	Water	• Ministry of Water & Irrigation • Ministry of Environment and Mineral resources	• Water Resources Management Authority • Water Services Regulatory Board • Kenya Water Institute • National Water Conservation & Pipeline Corporation • Nairobi City Water and Sewerage Company • Athi Water Services Board • NEMA	• Kenya water industry association • Kenya Water for Health Organization • Institute of Environment and Water Management (IEWM) • Water Supply and Sanitation Collaborative Council (WSSCC) • Kenya Water and Sanitation Network (KEWASNET) • Hakijamii • Water Services Providers Association (WASPA),	• WASH Alliance International-Kenya • Haki Water • Water Aid Kenya • Global Water Partnership Alliance • Water & Sanitation for the Urban Poor (WSUP) •
	Security and Safety	• Ministry of Interior and Coordination of National Government • Independent Policing Oversight Authority • National Police Service Commission • The Kenya Defence Forces; • The National Intelligence Service; And • The National Police Service	• Radiation Protection Board • KCAA Kenya Civil Aviation Authority • National Disaster Management Unit • National Security Co-ordination centre • Department of Occupational Health and Safety (DOSHS) • National Security Coordination Centre • Kenya National Commission on Human Rights	• Regional Disaster Management Centre of Excellence • Amnesty International Kenya • International Commission of Jurists • Independent Medico-Legal Unit. • National Coalition of Human Rights Defenders	• United Nations High Commission for Refugees (UNHCR) • Embassy of Denmark (DANIDA) • Centre for Human Rights and Policy Studies (CHRIPS)

	Statutory A (Ministries/Agencies and Institutions)		Statutory B Ministries/Agencies and Institutions	Non-Statutory A	Non-Statutory B
			• County Policing Authoritiee		
	Land	• Ministry of Land, Housing and Urban Development	• National Lands Commission • Environment and Lands Court • Nairobi, Kajiado, Machakos County Comissioners • County Land Management Boards (CLMB)	• Kenya Land Alliance • Land Development and Governance Institute • Estate Agents Registration Board • Institution of Surveyors of Kenya • Centre for Environmental Justice and Development (CEJAD) • Kenya Alliance of Resident Associations (KARA) • Hakijamii	• International Land Coalition (ILC)
Coastal counties – Mombasa – Kwale – Kilifi – Tana river – TaitaTaveta – Lamu	Energy	• Department of Trade, Energy & Industrialization Mombasa • Ministry of Energy and Petroleum • Nuclear Power and Energy Agency • Kenya Electricity Transmission Company (KeTRACO) • Kenya Electricity Generating Company (KeGEN) • Geothermal Development Company (GDC) • Energy Regulatory Commission (ERC) • Kenya Power & lighting Company (KPLC)	• KPLC • KeTRACO • KeNGEN • Pwani University • Technical university of Mombasa • Vision 2030 Delivery Secretariat • Ministry of Devolution and Planning • Ministry of Labor & East Africa Affairs • Ministry of Industrialization and Enterprise Development • The Nuclear Power and Energy Agency • Vision 2030 Delivery Secretariat • County Governments	• Pastoralists Development Network of Kenya • Kenya Renewable Energy Association (KEREA) • Amu power • KEPSA • Kenya Association of Manufacturers •	• International Atomic Energy Agency (IAEA) • International Energy Agency • UNDP • JICA • Nuclear Electricity Programme Implementing Organisation (NEPIO) • Independent Power Producers • China General Nuclear Power Corporation • ROSATOM Russia • Korea Electric Power Corporation

	Statutory A (Ministries/Agencies and Institutions)		Statutory B Ministries/Agencies and Institutions	Non-Statutory A	Non-Statutory B
		• Rural Electrification Authority • The National Council of Governors • Kenya Investment Authority (KenInvest)	• the National and Senate Assembly committee on Energy and petroleum • The Kenya Revenue Authority (KRA) • LAPSSET Development Authority		Korea Nuclear Association for International Cooperation
	Environment	• Department of Water, Environment, Minerals & Natural Resources Mombasa County • National Environment Management Authority	• Kenya Marine and Fisheries research institute • County Environment Committees to the 6 counties • National Museum of Kenya (NMK)	• Save Lamu • Kwale County Natural Resources Network • Likoni Community Development Programme • Environmental Trust of Kenya • Sustainable Community Environment Programme, Mombasa • Green Belt Movement • People in Active Management of Biodversity and Agriculture (PAMBA) Kilifi • Mombasa Tourism Association • Kwacha Africa • Eco- Ethic?s International - Kenya	• UN-HABITAT • WWF-Panda • UNESCO
	Land	• National Land Commission • Department of Lands, Housing and Physical Planning Mombasa county • County Community land Committees	KeNHA KURA County Lands Offices County Land Management Boards (CLMB)	• Coast People's Forum • Save Lamu • Muslims for Human Rights (MUHURI) • Kwale Human Rights Network • Kenya Alliance of Resident Associations (KARA)	• United States Agency for International Development (USAID). • Action Aid International Kenya (AAIK)

	Statutory A (Ministries/Agencies and Institutions)		Statutory B Ministries/Agencies and Institutions	Non-Statutory A	Non-Statutory B
				• Management of Arid Zones Initiatives & Development Options (MAZIDO) • Haki Yetu Organization	• Development Policy Management Forum (DPMF) • Red Cross
	Water	• Ministry of Water and Irrigation (MW&I), • Department of Water, Environment, Minerals & Natural Resources Counties • Coastal Water Service Board	• Kenya Marine and Fisheries research institute • Kenya Maritime Authority	• Mombasa Water and Sanitation Company Limited (MOWASSCO) • Malindi Water & Sewerage Company Limited (MAWASCO) • Kilifi-Mariakani Water and Sewerage Company Limited (KIMWASCO), • Coast People's Forum • Kwale Water and Sewerage Company (KWAWASCO) • Tavevo Water and Sewerage Company Limited (TAVEVO) • Lamu Water and Sewerage Company Limited (LAWASCO)	• World Bank • Kenya Water for Health Organization (KWAHO), Mombasa
	Security/safety	• Ministry of Interior and Coordination of National Government (MoICNG) • Independent Policing Oversight Authority • National Police Service Commission • the Kenya Defence Forces; • the National Intelligence Service; and • the National Police Service	• National & County Security Committees (NCSCs) • County Commissioners • Kenya Ports Authority • Kenya Maritime Authority	• Haki Yetu Organisation • Council of Imams and Preachers of Kenya (CIPK) • Coast Interfaith Council of Clerics (CICC)	Kenya Red Cross

	Statutory A (Ministries/Agencies and Institutions)		Statutory B	Non-Statutory A	Non-Statutory B
			Ministries/Agencies and Institutions		
North Rift (Eldoret) – Baringo – Elgeyo Marakwet – Turkana – West Pokot – Marsabit	Energy	• Ministry of Energy and Petroleum • Nuclear Power and Energy Agency • Kenya Electricity Transmission Company (KeTRACO) • Kenya Electricity Generating Company (KeGEN) • Geothermal Development Company (GDC) • Energy Regulatory Commission (ERC) • Kenya Power & lighting Company (KPLC) • Rural Electrification Authority • The National Council of Governors • Kenya Investment Authority (KenInvest)	• Ministry of Devolution and Planning • Ministry of Labor & East Africa Affairs • Ministry of Industrialization and Enterprise Development • The Nuclear Power and Energy Agency • Vision 2030 Delivery Secretariat • County Governments • the National and Senate Assembly committee on Energy and petroleum • The Kenya Revenue Authority (KRA) • LAPSSET Development Authority Moi University University of Eldoret Turkana University College	• Lake Turkana wind power • KEPSA • Kenya Renewable Energy Association (KEREA) • Kenya Association of Manufacturers •	• International Atomic Energy Agency (IAEA) • International Energy Agency • UNDP • JICA • Nuclear Electricity Programme Implementing Organisation (NEPIO) • Independent Power Producers • China General Nuclear Power Corporation • ROSATOM Russia • Korea Electric Power Corporation • Korea Nuclear Association for International Cooperation
	Water	• Ministry of Water and Irrigation (MW&I)	• Lake Victoria North Water Services Board • Northern Water Services Board (NWSB)	• Friends of Lake Turkana • Eldoret Water and Sanitation Company	• USAID • UNESCO • Oxfam • World Vision •
	Environment	• Kenya Meteorological Department (KMD) • NEMA	KWS KFS County Environment Committee	• Centre for Environmental Development • Turkana Development Organizations Forum (TuDO) • TIMU • Kitale Nature Conservancy	• UNEP • International Union for Conservation of Nature (IUCN), • UN-HABITAT

	Statutory A (Ministries/Agencies and Institutions)		Statutory B Ministries/Agencies and Institutions	Non-Statutory A	Non-Statutory B
				• Green Belt Movement •	
	Land	Ministry of Lands & Physical Planning National Government	• National Land Commission • County land management (Control) boards • community Lands Committees • Sub-counties Land Control Boards	• Turkana Basin Institute • Pastoralists Development • Kenya Land Alliance • Turkana Pastoralists Development Organization (TUPADO) • Lokichogio Kakuma Development Organization(LOKADO) • Turkana development organization forum-(TUDOF)	• Catholic Organization for Relief and Development (Cordaid) • Initiatives for Land, Lives and Peace
	Security/Safety	• Ministry of Interior and Coordination of National Government (MoICNG) • Independent Policing Oversight Authority • National Police Service Commission • the Kenya Defence Forces; • the National Intelligence Service; and • the National Police Service	• National & County Security Committees (NCSCs) • Radiation Protection Board • KCAA Kenya Civil Aviation Authority • National Disaster Management Unit • National Security Co-ordination centre • Department of Occupational Health and Safety (DOSH) • National Security Coordination Centre • Kenya National Commission on Human Rights	• Timu • University of Eldoret •	• United States Aid Agency (USAID) • Initiatives of Change (IofC) international • Red Cross Society (KRCS) • Oxfam • water aid America
Western (Kisumu-Maseno) Kisumu County Siaya county	**Energy**	• Ministry of Energy and Petroleum • Nuclear Power and Energy Agency	• Ministry of Devolution and Planning • Ministry of Labor & East Africa Affairs	• KEPSA • Kenya Renewable Energy Association (KEREA)	• International Atomic Energy Agency (IAEA)

	Statutory A (Ministries/Agencies and Institutions)		Statutory B	Non-Statutory A	Non-Statutory B
			Ministries/Agencies and Institutions		
Homabay County, Migori County Kakamega Vihiga Busia Bungoma		• Kenya Electricity Transmission Company (KeTRACO) • Kenya Electricity Generating Company (KeGEN) • Geothermal Development Company (GDC) • Energy Regulatory Commission (ERC) • Kenya Power & lighting Company (KPLC) • Rural Electrification Authority • The National Council of Governors • Kenya Investment Authority (KenInvest)	• Ministry of Industrialization and Enterprise Development • The Nuclear Power and Energy Agency • Vision 2030 Delivery Secretariat • County Governments • the National and Senate Assembly committee on Energy and petroleum • The Kenya Revenue Authority (KRA)	• Kenya Association of Manufacturers • Maseno University • Masinde Muliro University of Science and technology • Jaramogi Oginga Odinga university • Rongo University • Tom Mboya University college, Kisii University	• International Energy Agency • UNDP • JICA • Nuclear Electricity Programme Implementing Organisation (NEPIO) • Independent Power Producers • China General Nuclear Power Corporation • ROSATOM Russia • Korea Electric Power Corporation • Korea Nuclear Association for International Cooperation
	Environment	• Meteorological Department • National Environment Authority (NEMA) • Environment and Land Court • Climate Change Directorate	• County Environmental Director NEMA • County Environmental Community • Counties Ministry of issues related to environment • National Environmental Complaints Committee	• LVEMP • Friends of Lake Victoria (OSIENALA) • Busia Environmental and Resource Management (BERMA) • Green Belt Movement • Community Mobilization Against Desertification (C-MAD) Nyanza Sustainable Agriculture and Rural Development Programme	• UNEP • DANIDA • EUROPEAN UNION •
	Land	Ministry of Lands & Physical Planning National Government	• National Land Commission	• Civil Society Organization Network • PELUM Kenya	• United Nations Development Programme

	Statutory A (Ministries/Agencies and Institutions)		Statutory B	Non-Statutory A	Non-Statutory B
			Ministries/Agencies and Institutions		
			• County land management (Control) boards • community Lands Committees • Sub-counties Land Control Boards	• Kenya Land Alliance • council of elders	(UNDP)-Amkeni Wakenya • Emabsy of Sweden • Norwegia Embasy • USAID
	Security/Safety	• Ministry of Interior and Coordination of National Government • Independent Policing Oversight Authority (IPOA) • Anti-terrorism police unit (ATPU) • Internal Security Affairs; • DOSH • KEBS • NEMA	• County Commissioner • Kenya National Commission on Human Rights (KNCHR) • Disasters and Emergency Response Coordination; National • Disaster and Operation Centre; • County Commissioners	• National Council of Churches of Kenya (NCCK) • Catholic Justice and Peace Commission (CJPC),	• World Vision • Kenya Red Cross Society (KRCS)
	• Water	• Water Services Trust Fund (WSTF) • National Ministry	• Lake Victoria South water service Board • Lake Victoria North Water Service Board • South Nyanza Water supply LTD • KIWASCO • GWASCO • MIWASCO • HOMAWASCO	• Nzoia Water Services Company • Western Water Services Company • Amatsi Water Services Company • Kapsabet Nandi Water and Sanitation Company	• LVDB • SANA international • UNICEF • African Development Bank Group • Agence Francaise De Development •

Source: (SGS, 2019)

5.6 Stakeholder Engagement Plans for each stage of Decision-making stages

Stakeholder involvement objectives were set for each stakeholder group as prioritized. The concerns of each stakeholder are defined for each phase of the nuclear power programme. Their level of engagement expected is determined including methods to be used for each stakeholder identified tested and capacity built. A communication plan was developed whose objective was to deal with concerns associated with different stakeholder groups.

The three key decision-making stages were used to define and plan for the full cycle involvement of both statutory and non-statutory stakeholders: the nuclear introduction phase, the operations or expansion phase and the decommissioning phase. The involvement concerns of stakeholder in each phase are different and so are the objectives that define involvement in each phase. Methods and tools for targeting involvement of each identified stakeholder were then described depending on if the stakeholder group is statutory or non-statutory.

An evaluation method ensures the lessons learnt in each round of engagement campaigns are used to improve subsequent engagements. The communication plan ensures Information, Education and Communication is in-built according to the needs, access and formats of target stakeholders. The objectives of involvement for each stakeholder group are reviewed continuously based on their concerns, capacities and determined by sharing Information & Education, Communication, Consultation or if the objective is dialoguing decisions.

Table 5-5below shows the statutory involvement in decision making while Table 5-6 bears the Stakeholder Engagement and Management Plan.

Table 5-5: Statutory Involvement in decision making

Activities in Statutory involvement	Examples of Activities in Non-statutory involvement
▪ Stakeholder involvement during Licensing ▪ Business Licensing according to the Companies Act ▪ Investment and Financial Requirement's Nuclear Agency Regulations ▪ Safety requirements according to security standards ▪ Environmental & Social Assessments & licensing under EMCA; ▪ Energy licensing according to energy regulations and transmissions ▪ Radiation licensing according to relevant regulations ▪ Land acquisition licensing according to NLC Act ▪ Emergency planning and response plans licensing ▪ Nuclear Regulatory Agency Licensing	▪ Review of adequacy and compliance with Legislative framework (national and host county level); ▪ Review of Institutional governance mechanisms that build, influence, networks working with media, civil society (health, environment, safety, land), security and ▪ ESIA based engagement mechanisms ▪ Consultation interventions where decision-making is required ▪ Socio-economic interventions partnering with communities ▪ Any interventions and engagement that affects stakeholders during operation of the facility ▪ Agreements on land use of safety-zones with communities and non-state actors ▪ General and periodic statutory and non-statutory information dissemination by actors.

Source: (SGS, 2019)

Table 5-6: Stakeholder Engagement Plan for Development of Nuclear Power

a) Nuclear Development Phase Stakeholder Involvement Management Plan						
	Stakeholder	**Objective**	**Baseline concerns**	**Methods & Tools**	**Engagement plan**	**Time/resource**
Statutory	Partnership stakeholders	Introduction to nuclear power	Why nuclear Energy in Kenya?	Technical Studies on energy mix planning options; Inter-department meetings and joint decision studies & reports	Consultations and decision-making on energy options and objectives in sync	Planning, roles, time and resource planning
	Specialised information Stakeholders		Alternatives Energy to Nuclear?	Energy mix information and debate; Inter-department communication	Studies on the energy mix options for Kenya and	Plan time and engagement resources
	Lay language information stakeholders		Nuclear technology	Public information on nuclear technology; Open info policy	Websites and social media info on nuclear technology	Plan time and engagement resources
	Involvement stakeholders		Governance regulations of nuclear in Kenya	Consultative & info on safeguards, safety, radiation and decommissioning regulations of nuclear; inter-department communication and reporting	Consultation with & capacity building relevant agencies in working with nuclear & expected standards	Plan time and engagement resources
Non-statutory	Partnership stakeholders	Introduction of nuclear power	Why nuclear Energy in Kenya?	Participation in nuclear studies & decisions	Nuclear Legislative, SESA, ESIA and Siting decisions	Plan time and engagement resources
	Specialized information stakeholders		Alternatives Energy to Nuclear?	Involvement in technical energy debates	Energy mix facts data and debates forums	Plan time and engagement resources
	Lay language information stakeholders		Energy mix debate that include Nuclear.	Open information on nuclear vs nuclear energy	Websites and social media info on nuclear technology	Plan time and engagement resources
	Involvement stakeholders		Governance regulations of nuclear in Kenya	Legislative debates on nuclear & energy governance debates and decisions	Options for better that improve transparency and accountability of decisions	

b) Nuclear Operations Phase Stakeholder Involvement Management Plan

	Stakeholder	Objective	Baseline concerns	Methods & tools	Engagement plan	Time/resource
Statutory	Partnership stakeholders	Siting and operating a nuclear facility with trusted governance	How do we manage existing Siting risks?	Administrative involvement in legislative framework	Admin partnerships between National & Regional partnership in nuclear siting process decisions	Planning short and long-term time and resource
	Specialised information Stakeholders		Siting options for nuclear Energy?	Administrative participation in siting options decisions	Administrative roles, communications and collaborations between National & county government relevant departments	Plan time and engagement resources
	Lay language information stakeholders		Siting risks and benefits? What are Safe operations of a site?	Open Information on siting process administration and decisions, risks and benefits	Regional, county & Community engagements, capacity building and consultation with transparent information sharing	Plan time and engagement resources
	Involvement stakeholders		Governance SWOT of siting options	Regional regulations and community agreements on siting nuclear facilities	Technical information reporting, consultation and roles play capacity building	Plan time and engagement resources
Non-statutory	Partnership stakeholders	Siting and operating a nuclear facility with trusted governance	What are the Management risks & opportunities in available Siting options?	Regional and community intervention partnerships based on agreements	Capacity building, joint projects, reporting and interventions	Plan time and engagement resources
	Specialized information stakeholders		Siting options for nuclear Energy?	Sharing specialized information and capacity for joint local information interventions	Information sharing tools and standards for managing those information	Plan time and engagement resources
	Lay language information stakeholders		Siting risks and benefits?	Open local and community information and intervention management	Local information, education and communication	Plan time and engagement resources
	Involvement stakeholders		Governance SWOT of siting options	Capacity building and consultations to manage & monitor local interventions decisions	Monitoring tools on local nuclear positions and effect of option interventions	Plan time and engagement resources

c) Nuclear facility Decommissioning Phase Stakeholder Involvement Management Plan

Stakeholder	Objective	Baseline concerns	Methods & Tools	Engagement plan	Time/resource
Partnership stakeholders	Making the best decommissioning decisions and maintaining trusted governance	Nuclear facility Closure decisions	Joint local and international Technical Studies of options of closure decisions scenarios'	Joint long term technical capacity building on decom6missioning administrative roles	Planning, roles, time and resource planning
Specialised information Stakeholders		Waste fuel management governance	Technical information and studies on roles & standards during waste management decisions options	Technical information exchange and review of decommissioning decision options	Plan time and engagement resources
Lay language information stakeholders		SWOT on waste facility siting	SESA, ESIA and public engagement using local and mainstream & social, community media to share basic open information on SWOT of waste facility	Share basic open accountable information based on transparent communication, technology education and information.	Plan time and engagement resources
Involvement stakeholders		Location of waste facility and nuclear facility	Consultations meetings and reports on technical issues and roles related to nuclear decommissioning governance	Long term technical consultations and joint reporting on status and options in nuclear decommissioning	Plan time and engagement resources
Partnership stakeholders	Making the best decommissioning decisions and maintaining trusted governance	Nuclear facility Closure decisions	Capacity building technical partnership meetings and joint roles with stakeholder to ensure operations trust and confidence is maintained	Joint technical analysis and reporting on decommissioning options, roles & standards	Plan time and engagement resources
Specialized information stakeholders		Waste fuel management governance	Sharing specialized information on decommissioning studies, standards, rules and roles	Sharing Technical studies and reports on decommissioning options	Plan time and engagement resources
Lay language information stakeholders		SWOT on waste facility siting	Open communication through mainstream, social, community media on decommissioning decisions	Open communication, information and education on decommissioning	Plan time and engagement resources
Involvement stakeholders		Location of waste facility and nuclear facility	Technical Consultations meetings, studies, reports and training on decommissioning options	Joint technical studies and reports on decommissioning options	Plan time and engagement resources

Source: (SGS, 2019)

5.7 Stakeholder engagement discussions

The public consultation is a key component of the SESA and participation of various stakeholders greatly contributes to the success of any policies, plans and programmes. This involved gathering environmental information, i.e. baseline data, potential impacts and mitigation measures from stakeholders to ensure a comprehensive SESA report is produced.

This process contributes to the general acceptability of the proposed programme especially by the locals. A rigorous stakeholder engagement process is a requirement of SESA as stipulated in the SESA guidelines, 2012 and under EMCA, Cap 387 approach where representatives from NuPEA and SGS Kenya introduced the components of the nuclear programme and presentations on environmental issues including mitigation of the adverse impact respectively. This step was followed by a question and answer session between the County officials, NuPEA and SGS Kenya as represented in the minutes attached as annex II. The County officials got the opportunity to hear from NuPEA employees are knowledgeable in nuclear technology. Some of the consultations were graced by the County Governors, Deputy Governors, local politicians and County Executives.

The discussions surrounded nuclear energy and its components below are some of the general views on nuclear energy. The thematic areas were description of nuclear plants and financing, siting criteria, justification for inclusion of nuclear energy in our energy mix, nuclear accidents and impacts of nuclear energy development on natural resources, regulatory framework, benchmarking and biodiversity in the region.

The more specific concerns were surrounding procurement; sources of uranium and equipment, stakeholder engagement, management of radiative waste, development of a grid, health and safety, security, compensation where applicable, protection of natural resources like ground water, community benefits including revenue and integration of the proposal into the existing County and it's impacts on the community.

The environmental and social impacts that were cutting across all regions were management of spent fuel (radioactive material), pollution of the water and soil, social benefits to the community such as revenue allocation to the County and employment of the locals, compensation from loss of livelihood due to the high demand of water, health and safety of the workers and the public, thermal impacts and loss of fish eggs among others.

Mitigation measures were discussed and suggested as follows, the nuclear reactor has no direct contact with water hence no contamination expected, there is engineered safety to protect the community from nuclear accidents, more sensitization for the communities that will be in the candidate area to further expound on mitigation of livelihood related impacts. Other impacts such as revenue sharing could not be addressed since the development of a regulation to govern this is required. This may form part of way forward.

In conclusion, the stakeholders understood the concepts of nuclear energy and recommended more sensitization especially at grassroots level for better understanding. Benchmarking visits can form part of this solution. The integration of nuclear energy within the current County plans should be a systematic and objective process. Once a site is selected, in-depth consultation and public participation will be done to enhance nuclear energy acceptability.

5.8 SESA Stakeholder Engagement Programme

The tables below provide important details regarding the stakeholder process and for the KNNP SESA including dates and venues when consultations meetings were undertaken (Table 5-7 andTable 5-8) and summary of pertinent issues raised in the meetings (Table 5-9). The minutes and attendance sheets for these meeting are annexed to this report as Annex II and III respectively.

Table 5-7: Phase 1 Stakeholder Meetings

	Region /Counties	Dates	Comments
1.0	**LOWER COASTAL REGION**		
1.1.	**Kwale County**	**15th January 2018**	a) Invitation letters were sent by 5th January 2018 and confirmations followed b) We included a wider selection of participants from County Executive, Assembly, University college and Environment /Water & marine related NGO's; County NEMA
1.2.	**Mombasa County**	**17th January 2018**	a) Invitation letters were sent by 5th January 2018 and confirmations followed b) We included a wider selection of participants from County Executive, Assembly, University college and Environment /Water & marine related NGO's; County NEMA
1.3.	**Kilifi County**	**19th January 2018**	a) Invitation letters were sent by 5th January 2018 b) We included a wider selection of participants from County Executive, Assembly, county University college and Environment /Water & marine related NGO's; water basin authority; County NEMA

Source: (SGS, 2019)

Table 5-8: Phase 2 Stakeholder Meetings

	Region /Counties	Dates	Comments
1.0	**WESTERN/NYANZA REGION**		
1.1.	**Kisumu County**	**12th February 2018**	a) Invitation letters were sent by 5th and confirmations followed b) We included a wider selection of participants from County Executive, Assembly, University college and Environment /Water & marine related NGO's; County NEMA; Lake Basin Authority
1.2.	**Siaya County**	**14th February 2018**	a) Invitation letters were sent by 5th and confirmations followed b) We included a wider selection of participants from County Executive, Assembly, University college and Environment /Water & marine related NGO's; County NEMA, Lake Basin Authority
1.3.	**Busia County**	**16th February 2018**	a) Invitation letters were sent the by 5th and confirmations followed b) We included a wider selection of participants from County Executive, Assembly, University college and Environment /Water & marine related NGO's; County NEMA; Environment /Water related NGO's; water basin authority
1.4.	**Homa Bay County**	**19th February 2018**	a) Invitation letters were sent the by 5th and confirmations followed b) We included a wider selection of participants from County Executive, Assembly, University College and Environment/Water & marine related NGO's; County NEMA; & Lake Victoria related NGO's;
1.5.	**Migori County**	**22nd February 2018**	a) Invitation letters were sent by 12th and confirmations sought

			b) We included a wider selection of participants from County Executive, Assembly, South University College and Environment /Water & Lake Victoria related NGO's;
	NORTH RIFT		
2.1	**Turkana County / Lodwar Meeting**	**19th March 2018**	a) Invitation Letters were sent by 5th March 2018. b) We included a wider selection of participants from County Executive, Assembly, Turkana University college and Environmental/ Water & Lake Turkana related NGO's County NEMA; Lake Basin Authority
2.2	**Uasin Gishu /Eldoret Meeting**	**21st March 2018**	Invitation letters were sent by 5th March 2018 a) critical Hub for North Rift if any site is proposed in the north rift; b) Members of counties assembly and CES's that were invited. c) Academia and NGO's; County NEMA; North Rift Basin Authority were also invited.
2.3	**Nandi County (Kapsabet Town)**	**23rd March 2018**	
3	**SOUTH RIFT (Week 2)**		
3.1	**Kericho County**	**26th March 2018**	a) Invitation letters were sent by 5th March 2018 b) we included a wide selection of participants from CES's, Assembly, South University College and Environment/ Water & related NGO's
3.2	**Bomet County**	**27th March 2018**	
3.3	**Nakuru County**	**29th March 2018**	
4	**CENTRAL REGION**		
4.1	**Murang'a County**	**18th June 2018**	a) Invitation letters were sent by 5th June 2018 and confirmation sought. b) We included a wide selection of participants from County CEC's, County Assembly, University & College and Environment/ Water & related NGO's
4.2	**Nyeri County**	**19th June 2018**	
4.3	**Meru County**	**20th June 2018**	
4.4	**Embu County**	**21st June 2018**	
4.5	**Kitui County**	**25th June 2018**	
4.6	**Garissa County**	**28th June 2018**	
5	**UPPER COASTAL REGION**		
5.1	**Lamu County**	**10th July 2018**	a) Invitation letters were sent Early, and confirmations followed. b) We included a wider selection of participants from County Government, Universities & colleges, Energy and Environment /Water; related NGO's and NGO's; NEMA; Water Authority
5.2	**Tana River County**	**12th July 2018**	

Nairobi Meeting

6.0.	**Nairobi**	**Dates**	**Comments**
6.1	**Nairobi National and Metropolitan Region Stakeholders Workshop**	**July 2019**	a) Invitation letters were sent early, and confirmations followed. b) Include a wider selection of participants from Energy Ministry, Universities departments in Nuclear, Energy and Environment /Water; related NGO's and NGO's; NEMA; Water Authority

Source: (SGS, 2019)

Table 5-9: Pertinent Issues Raised

Issue	Response
Kenya needs cheaper reliable electricity. We need to improve generation and distribution; There are concerns about "costs of power"; how would 4,000MW NPP help alleviate these concerns?	This is a participatory and inclusive process and will not compete with coal or any other energy source. The energy mix includes different sources of energy to ensure a cheap reliable electricity.
Does Kenya have uranium sources to use or reliable nuclear fuel?	NFC includes front-end, reactor services and Back end. Kenya will be involved in reactor services, either once-through or closed NFC. The choice is yet to be made. To acquire Nuclear fuel Kenya with either purchase finished fuel elements within a long-term supplier contract
What technology assessment has been done so far and how has it improved nuclear as a source of power?	Reactor Technology Assessment (RTA): is the methodology of evaluation, selection & deployment of the best nuclear reactor technology to meet the design objectives suitable for Kenya. Design options for PWR and BWR are being considered
What is the capital investment for the NPP?	The NPP has a high capital cost. The GOK is funding current activities. A financing option like Build Operate Transfer (BOT) is being considered to cater for $500M estimate for 1000MW NPP.
What are the industrial benefits of hosting an NPP?	At the construction & operations phase specific areas like cement, steel, machinery equipment and chemical supply, will be allocated to Kenya industries and services companies. A planning process to achieve this is on-going.
What progress has been made in drafting of legal instruments requisite for NPP development?	A Bill to legislate nuclear is on covering areas as nuclear safety, security, safeguards and civil liability for nuclear damage for all the nuclear power plants to be established, operated and decommissioning. Additionally, Institutional & organisational framework with competences measures & procedures. An independent national regulatory body will be in place to manage NPP
What Partnerships would be made between the central government and the county governments in the implementation of the NPP?	Involvement of key statutory & non-statutory stakeholders is expected to enable the development and sustenance of a national position on nuclear. SESA provides an initial involvement opportunity that will be continued towards the national position. Siting and ESIA will include more specific involvement.
What capacity development has been done locally for Human Resource Development to handle NPP?	A strategic development of the knowledge and skills necessary to purchase, operate, maintain and comply within the regulatory requirements of a nuclear power, is on-going, spreads across most scientific and engineering disciplines, includes exposure to similar nuclear facilities in different partner countries like S-Korea, China and US.
What safeguards are there to ensure the facility handles materials to international standards	Kenya has shown political goodwill and taken necessary measures to establish and implementing a State System of Accounting and Control of nuclear materials (SSAC) according to IAEA Secretariat set of Safeguards that verify the correctness & completeness of declarations.

Issue	Response
What are the key Nuclear safety areas and has Kenya ratified international safety standards?	Nuclear Safety standards at siting, design, construction, commissioning, operations and dismantling of any NPP must achieve proper operating conditions, prevent or mitigate consequences of accidents, in a manner that protects workers, the public and the environment. Kenya has to ratify Convention on Nuclear Safety (CNS). Additionally, – The States carry full responsibility for nuclear security as a fundamental in management of nuclear technologies, in transportation and use of radioactive materials. Threats that can compromise national security, energy security, public safety and national economy must be managed at local & international level including within international treaties
In case of emergencies like we have (as seen in Ukraine and US) are we prepared to deal with them? If so, what are we doing and how can the county be involved?	Kenya is establishing national radiation emergency plans for response to nuclear and radiological emergencies. It has an existing disaster risk management policy to increase and sustain resilience of vulnerable communities to hazards.
What environmental impacts are potential for the design proposed to our people, water, and other biodiversity? How are they going to be managed?	Kenyans and both present and future the environment, must be protected against harmful radiation risks through the IAEA International Basic Safety Standards (BSS) with requirements for protection against risks associated with exposure to ionizing radiation. Kenya is party to several Multilateral Environmental Agreements (MEAs) for environmental protection which influence the development of KNPP. This SESA & an ESIA will also be carried out.
What policies and institutional framework are we building for ensuring radiation protection?	The country is upgrading management systems for exposure to nuclear radiation beyond acceptable legal limits.
Is safe long-term Radioactive Waste disposal possible within the Kenya? How are we planning for it?	Nuclear waste management is a critical policy that manages radioactive waste handling, pre-treatment, treatment, conditioning, transport, storage and disposal. We either burry it or the supplier collects it. It can also be re-used
What measures have been put to address competition of water resources between the communities within the candidate sites and NPP operations	Reactor Technology Assessment (RTA): is the methodology of evaluation, selection & deployment of the best nuclear reactor technology to meet the design objectives suitable for Kenya. Design options for PWR and BWR are being considered.
Are we ready to procure Nuclear given our corruption and poor adherence to standards?	Local workforce competence is being developed to implement a NPP procurement, with legal, -contractual, physical construction, financing and environmental issues that weigh in on the quality and context of the procurement of nuclear facilities. It may include upgrading the procurement act, local content & standards
Is Kenya Ready to handle nuclear radiation and ionizing impacts?	Radiation Protection: The country is upgrading management systems for exposure to radiation beyond acceptable legal limits.

Source: (SGS, 2019)

6 CHAPTER SIX: IMPACT IDENTIFICATION AND ANALYSIS

6.1 Introduction

The environmental and social baseline information; consultation and public participation; and the NPP details as discussed earlier, formed the basis for impact identification and evaluation. Additionally, literature review of published reports, scientific papers and other approved SESAs was conducted by the team of experts to provide a complete list of expected impacts. The impacts that are expected to arise from the NPP execution could either be termed as positive, negative, direct, indirect, short-term, long-term, temporary, and permanent depending on their area of cover and their stay in the environment. This section also gives details about the potential cumulative impacts from the programme as a purpose of subject the Programme to the SESA process

This chapter gives a highlight of impacts analysis. Prediction and evaluation of impacts, including cumulative effects have been clearly documented including trade-offs. The positive and negative impacts likely to originate from the execution of the Strategic plan for the NPP in Kenya, 2013 are described based on social and biophysical environment and the economic aspects.

6.2 Environmental Impacts of the Nuclear Power Programme

The detailed study was undertaken through four stages:

- **Stage 1:** Identification of environmental and social impacts, safety and occupational health risks, and possible mitigation measures at policy level,
- **Stage 2**: Description of the regulatory and institutional framework and assessment of capacity and identification of policy gaps,
- **Stage 3**: Analysis of the emerging issues/gaps and gap-filling options, and
- **Stage 4:** Recommendations

These concerns were obtained through interviews, stakeholder consultations and case studies from other countries. Stakeholder concerns were evaluated on the basis of social, economic and environmental impacts, the severity of the impacts and the numbers of people likely to be impacted. Impacts associated with nuclear power production vary by phases as shown in Chapter 1, and include direct, indirect, and cumulative impacts which may occur on land, offshore, continental shelves, deep sea, ASALs, wetlands, forests, animal parks and other fragile ecosystems. The following concerns of greater importance were selected and prioritised for detailed studies during SESA.

6.2.1 Background of Nuclear Power and its Environmental and Social Impacts

This section gives a general overview of the Kenyan environment and the potential negative impacts on it as a result of nuclear power development activities in addition to the infrastructural development identified in the PPPs chapter. Kenya has significant biodiversity and enjoys a unique tropical climate with varying weather patterns due to differing topographical dimensions. The country has a wide variety of ecosystems namely mountains, forests, arid and semi-arid areas (ASALs), freshwater, wetlands, coastal and marine areas, all offering many opportunities for sustainable human, social and economic development. These ecosystems are natural capitals which provide important ecosystem regulatory services (such as forests and mountains which regulate water flow and sustain biodiversity), provisional services (such as provision of timber and fuel wood by forests), cultural services (such as

aesthetic, recreational or spiritual values and uses) and supporting services (like soil formation, nutrient cycling and primary production).

The survival and socio-economic wellbeing of Kenyans is ultimately intertwined with the environment. Most Kenyan citizens depend directly or indirectly on environmental goods and services. In addition, Kenya's environmental resources contribute directly and indirectly to the local and national economies through revenue generation and wealth creation in sectors such as agriculture (including fisheries and livestock), water, energy, forestry, trade, tourism and manufacturing.

The promulgation of the Constitution of Kenya 2010 marked an important chapter in Kenya's environmental policy development in the context of climate change. Hailed as a 'Green' Constitution, it includes elaborate provisions with considerable implications for sustainable development. These range from environmental principles and implications of Multilateral Environmental Agreements (MEAs), to the right to a clean and healthy environment as enshrined in the Bill of Rights. Chapter IV of the Constitution is entirely dedicated to land and the environment. It also incorporates a host of social and economic rights which are of environmental character such as the right to water, food, and shelter, among others.

Kenya has fairly adequate environmental policy and legal frameworks with regulations on EIA and SESA. However, much of the emphasis is on project approval processes, rather than on a life cycle approach to minimizing environmental and social impacts at the strategic level. Environmental monitoring and project follow-up are considered part of the EIA. Nevertheless, in most cases actual enforcement is inadequate, environmental monitoring is insufficient and monitoring data is not widely disclosed to the lead agencies, public and affected and interested stakeholders. Moreover, most counties have insufficient control and enforcement mechanisms during the post-EIA approval phase due to limited human, technical and financial capacity.

The international legal environment for the nuclear sector is quite extensive with a number of conventions that deal with security, safety and radioactive waste management. Kenya is a member to the following international legal structures: -

- The Convention on the Physical Protection of Nuclear Material (CPPNM);
- The Amendment to the Convention on the Physical Protection of Nuclear Material 2005, CPPNM.
- International Convention for the Suppression of Acts of Nuclear Terrorism (Nuclear Terrorism Convention).
- 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (LC PROT 1996).
- The Treaty on Non-Proliferation of Nuclear Weapons (the NPT).
- Comprehensive Nuclear Test Ban Treaty (the CTBT).
- Africa Nuclear Weapon-Free-Zone (Pelindaba) Treaty.

However, Kenya is yet to ratify the following important conventions on safety: -

- The Convention on Nuclear Safety.
- The Convention on Early Notification of a Nuclear Accident.
- The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.
- The Joint Convention on the Safety of Spent Fuel and on the Safety of Radioactive Waste Management.

- The 1963 Vienna Convention on Civil Liability for Nuclear Damage (as amended by the 1997 Protocol to amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage); and
- The Convention on Supplementary Compensation for Nuclear Damage.

Developing the nuclear power programmes and plans is a challenge, considering the inherent nature of the sector and the prevalent sensitivity of environmental issues in the country. However, the plan to develop the nuclear power production is significant for the economic development of the country by ensuring that Kenya's energy security is assured.

6.2.2 Types and Impacts of Radioactive Waste from the Reactors

Radioactive waste includes any material that is either intrinsically radioactive, or has been contaminated by radioactivity, and that is deemed to have no further use. Globally, government policies dictate whether certain materials – such as used nuclear fuel and plutonium – are categorised as radioactive waste. Radioactive waste must be managed under a special system of control.

Radioactive waste occurs in a variety of forms with very different physical and chemical characteristics, such as the concentrations and half-lives of the radionuclides. This waste may occur: in gaseous form, such as ventilation exhausts from facilities handling radioactive materials; in liquid form, ranging from scintillation liquids from research facilities to high level liquid waste from the reprocessing of used fuel; or ·in solid form, ranging from contaminated trash and glassware from hospitals, medical research facilities and radiopharmaceutical laboratories to vitrified reprocessing waste or used fuel from nuclear power plants when it is considered a waste.

Every radionuclide has a half-life – the time taken for half of its atoms to decay, and thus for it to lose half of its radioactivity. Radionuclides with long half-lives tend to be alpha and beta emitters, making their handling easier, while those with short half-lives tend to emit the more penetrating gamma rays. Eventually all radioactive waste decays into non-radioactive elements. The more radioactive an isotope is, the faster it decays. Radioactive waste is typically classified as either low-level waste (LLW), intermediate-level waste (ILW), or high-level waste (HLW), dependent, primarily, on its level of radioactivity.

- ***Low-level waste:*** Low-level waste (LLW) has a radioactive content not exceeding four gigabecquerels per tonne (GBq/t) of alpha activity or 12 GBq/t beta-gamma activity. LLW does not require shielding during handling and transport and is suitable for disposal in near surface facilities. LLW is generated from hospitals and industry, as well as the nuclear fuel cycle. It comprises paper, rags, tools, clothing, filters, *etc.*, which contain small amounts of mostly short-lived radioactivity. To reduce its volume, LLW is often compacted or incinerated before disposal. LLW comprises some 90% of the volume but only 1% of the radioactivity of all radioactive waste.

- ***Intermediate-level waste*****:** Intermediate-level waste (ILW) is more radioactive than LLW, but the heat it generates (<2 kW/m^3) is not sufficient to be taken into account in the design or selection of storage and disposal facilities. Due to its higher levels of radioactivity, ILW requires some shielding. ILW typically comprises resins, chemical sludge, and metal fuel cladding, as well as contaminated materials from reactor decommissioning. Smaller items and any non-solids may be solidified in concrete or bitumen for disposal. It makes up some 7% of the volume and has 4% of the radioactivity of all radioactive waste.

- ***High-level waste:*** High-level waste (HLW) is sufficiently radioactive for its decay heat (>2kW/m3) to increase its temperature, and the temperature of its surroundings, significantly. As a result, HLW requires cooling and shielding. HLW arises from the 'burning' of uranium fuel in a nuclear reactor. HLW contains the fission products and transuranic elements generated in the reactor core. HLW accounts for just 3% of the volume, but 95% of the total radioactivity of produced waste. There are two distinct kinds of HLW:

    - Used fuel that has been designated as waste.
    - Separated waste from reprocessing of used fuel.

HLW has both long-lived and short-lived components, depending on the length of time it will take for the radioactivity of particular radionuclides to decrease to levels that are considered non-hazardous for people and the surrounding environment. If generally short-lived fission products can be separated from long-lived actinides, this distinction becomes important in management and disposal of HLW.

HLW is the focus of significant attention regarding nuclear power and is managed accordingly. In terms of radioactivity, the major source arising from the use of nuclear reactors to generate electricity comes from the material classified as HLW. Highly radioactive fission products and transuranic elements are produced from uranium and plutonium during reactor operations and are contained within the used fuel. Where countries have adopted a closed cycle and reprocess used fuel, the fission products and minor actinides are separated from uranium and plutonium and treated as HLW. In countries where used fuel is not reprocessed, the used fuel itself is considered a waste and therefore classified as HLW.

LLW and ILW is produced as a result of general operations, such as the cleaning of reactor cooling systems and fuel storage ponds, and the decontamination of equipment, filters, and metal components that have become radioactive as a result of their use in or near the reactor. Radioactive waste, as a source of ionizing radiation, has long been recognized as a potential hazard to human health. Globally, National regulations and internationally recommended standards and guidelines dealing with radiation protection and radioactive waste management have been developed, based on a substantial body of scientific knowledge under the guidance of the technical expertise at IAEA.

6.2.3 Impact to Important Bird Areas (IBA)

Important Bird Areas (IBAs) are key sites and habitats that have been identified for the conservation of birds and other biodiversity. There are currently 60 IBA sites in Kenya that have a variant of endangered bird species (Bennun, L. et. al.,1999). These include woodlands, grasslands, forests and dry lands.

IBAs include sites that are protected and unprotected. The dangers/ pressure endangering IBAs have been identified as human activities such as overgrazing, agricultural encroachment, illegal logging, urbanization, etc. Some of the potential candidate sites lie within the area listed as IBA such as in the Tana River Basin and most of the Rift Valley water basins. Facilities associated with the Nuclear Power Programme will affect these important areas.

Besides the Important Bird Areas (IBA), there are also Endemic Bird Areas (EBA), which are areas of land identified by Bird Life International as being important for habitat-based bird conservation because it contains the habitats of restricted-range bird species, which are thereby endemic to them. The List below provides gazetted important bird areas in Kenya as reported by UNDP.

INTERNATIONAL LEVEL OF IMPORTANCE	NATIONAL IMPORTANCE	STATUS	DESCRIPTION OF STATUS	AREA SITE NO.
Aberdare Mountains	Aberdare Mountains	4	Improvement/Slight improvement/minor improvement	1
Amboseli National Park	Amboseli National Park	1	Major Decline	2
Arabuko-Sokoke forest	**Arabuko-Sokoke forest**	**4**	**Improvement/Slight improvement/minor improvement**	**3**
Busia grasslands	Busia grasslands	2	Decline/Slight decline	4
Cherangani Hills	**Cherangani Hills**	**2**	**Decline/Slight decline**	**5**
Chyulu Hills forests	Chyulu Hills forests	4	Improvement/Slight improvement/minor improvement	6
Dakatcha woodland	Dakatcha woodland	0	Unknown	7
Dandora ponds	Dandora ponds	1	Major Decline	8
Diani forest	**Diani forest**	**2**	**Decline/Slight decline**	**9**
Dida Galgalu desert	Dida Galgalu desert	0	Unknown	10
Dunga swamp	**Dunga swamp**	**2**	**Decline/Slight decline**	**11**
Dzombo Hill forest	**Dzombo Hill forest**	**0**	**Unknown**	**12**
Gede Ruins National Monument	**Gede Ruins National Monument**	**3**	**Stable/No change**	**13**
Kakamega forest	Kakamega forest	5	Major improvement	14
Kaya Gandini	**Kaya Gandini**	**3**	**Stable/No change**	**15**
Kaya Waa	**Kaya Waa**	**3**	**Stable/No change**	**16**
Kianyaga valleys	Kianyaga valleys	0	Unknown	17
Kikuyu Escarpment forest	Kikuyu Escarpment forest	5	Major improvement	18
Kinangop grasslands	Kinangop grasslands	2	Decline/Slight decline	19
Kisite island	**Kisite island**	**2**	**Decline/Slight decline**	**20**
Kiunga Marine National Reserve	**Kiunga Marine National Reserve**	**4**	**Improvement/Slight improvement/minor improvement**	**21**
Koguta swamp	Koguta swamp	2	Decline/Slight decline	22
Kusa swamp	Kusa swamp	2	Decline/Slight decline	23
Lake Baringo	**Lake Baringo**	**2**	**Decline/Slight decline**	**24**
Lake Bogoria National Reserve	**Lake Bogoria National Reserve**	**3**	**Stable/No change**	**25**
Lake Elmenteita	**Lake Elmenteita**	**3**	**Stable/No change**	**26**
Lake Magadi	**Lake Magadi**	**2**	**Decline/Slight decline**	**27**
Lake Naivasha	**Lake Naivasha**	**4**	**Improvement/Slight improvement/minor improvement**	**28**
Lake Nakuru National Park	**Lake Nakuru National Park**	**4**	**Improvement/Slight improvement/minor improvement**	**29**
Lake Turkana	**Lake Turkana**	**2**	**Decline/Slight decline**	**30**
Machakos valleys	Machakos valleys	0	Unknown	31
Marenji forest	**Marenji forest**	**2**	**Decline/Slight decline**	**32**
Masai Mara	Masai Mara	2	Decline/Slight decline	33
Masinga reservoir	Masinga reservoir	4	Improvement/Slight improvement/minor improvement	34
Mau forest complex	**Mau forest complex**	**4**	**Improvement/Slight improvement/minor improvement**	**35**
Mau Narok - Molo grasslands	**Mau Narok - Molo grasslands**	**1**	**Major Decline**	**36**
Meru National Park	Meru National Park	5	Major improvement	37
Mida Creek, Whale Island and the Malin	**Mida Creek, Whale Island and th**	**4**	**Improvement/Slight improvement/minor improvement**	**38**
Mount Elgon	Mount Elgon	2	Decline/Slight decline	39
Mount Kenya	Mount Kenya	2	Decline/Slight decline	40
Mrima Hill forest	**Mrima Hill forest**	**5**	**Major improvement**	**41**
Mukurweini valleys	Mukurweini valleys	2	Decline/Slight decline	42
Mwea National Reserve	Mwea National Reserve	2	Decline/Slight decline	43
Nairobi National Park	**Nairobi National Park**	**2**	**Decline/Slight decline**	**44**
North Nandi forest	North Nandi forest	2	Decline/Slight decline	45
Ol Donyo Sabache	Ol Donyo Sabache	0	Unknown	46
Ruma National Park	Ruma National Park	4	Improvement/Slight improvement/minor improvement	47
Sabaki river mouth	Sabaki river mouth	0	Unknown	48
Samburu and Buffalo Springs National Re	**Samburu and Buffalo Springs Nat**	**3**	**Stable/No change**	**49**
Shaba National Reserve	**Shaba National Reserve**	**2**	**Decline/Slight decline**	**50**
Shimba Hills	**Shimba Hills**	**2**	**Decline/Slight decline**	**51**
Sio Port swamp	**Sio Port swamp**	**2**	**Decline/Slight decline**	**52**
South Nandi forest	South Nandi forest	2	Decline/Slight decline	53
South Nguruman	South Nguruman	3	Stable/No change	54
Taita Hills forests	**Taita Hills forests**	**1**	**Major Decline**	**55**
Tana River Delta	**Tana River Delta**	**0**	**Unknown**	**56**
Tana River forests	**Tana River forests**	**1**	**Major Decline**	**57**
Tsavo East National Park	**Tsavo East National Park**	**2**	**Decline/Slight decline**	**58**
Tsavo West National Park	**Tsavo West National Park**	**2**	**Decline/Slight decline**	**59**
Yala swamp complex	**Yala swamp complex**	**2**	**Decline/Slight decline**	**60**

Figure 6-1: Gazetted important bird areas in Kenya as reported by UNDP Source: UNDP

Some of the IBAs with possible threats from the nuclear power activities depending on the most preferred candidate sites have been detailed in Chapter 3 especially under the biodiversity sections.

6.2.4 Impacts of Nuclear Power Programmes on Water Resources

Kenya's principal rivers are the 1,000-kilometers-long Tana and the 390 kilometers Athi River both flowing southeast to the Indian Ocean. Other rivers include the Ewaso Ng'iro flowing northeast to the swamps of the Lorian Plain, and the Nzoia, Yala and Gori, which drain into Lake Victoria. The choice of a candidate site is dependent on availability of reliable water for system cooling. Three choices are being sought for so far: Lake Victoria Basin; The Coastline (The Lower Tana River Basin and Lamu Coastline) and the Lake Turkana Basin.

Impacts on water resources could occur due to; water quality degradation from increases in turbidity, sedimentation, and salinity; spills; cross-aquifer mixing; water quantity depletion due to a span of activities related to nuclear power production, the associated infrastructural development; the fission process and energy production; to disposal of the radioactive waste.

During the construction of the nuclear plant, water would be required for dust control, consumptive use, and general support of infrastructural development activities. Depending on availability, it may be trucked in from off-site sources or obtained from local groundwater wells or nearby surface water bodies. Where surface waters are used for such activities, depletion of stream flows could occur. The generation of produced water can create several problems: water may be depleted from nearby aquifers; Produced water also may contain organic acids, alkalis, diesel oil, crankcase oils, and acidic stimulation fluids (e.g., hydrochloric and hydrofluoric acids).

The nuclear reactors, depending on their size, capacity and type, require different quantities of water during the various phases of construction and operation. However, the use and consumption of water in a nuclear power plant can be categorized into two main areas.

- Water used in cooling systems for the dissipation of the generated heat represents the majority of water use and consumption in the nuclear power plant lifetime.
- Use of industrial and potable water for plant service and operation: as for production of demineralized water for circuit make-up, sanitary water, firefighting, irrigation, etc.

The concepts of water withdrawal and water consumption are shown in **Figure 6-2** and **Figure 6-3** below. Open loop cooling systems (once-through) withdraw water from the sea, rivers or lakes to remove heat from the power plant. Once the cooling water is heated up, it is returned to its natural source. In comparison, closed loop cooling systems act as wet cooling towers which recirculate the cooling water. In this system, evaporation and other losses need to be supplemented by make-up which leads to water consumption from its natural source.

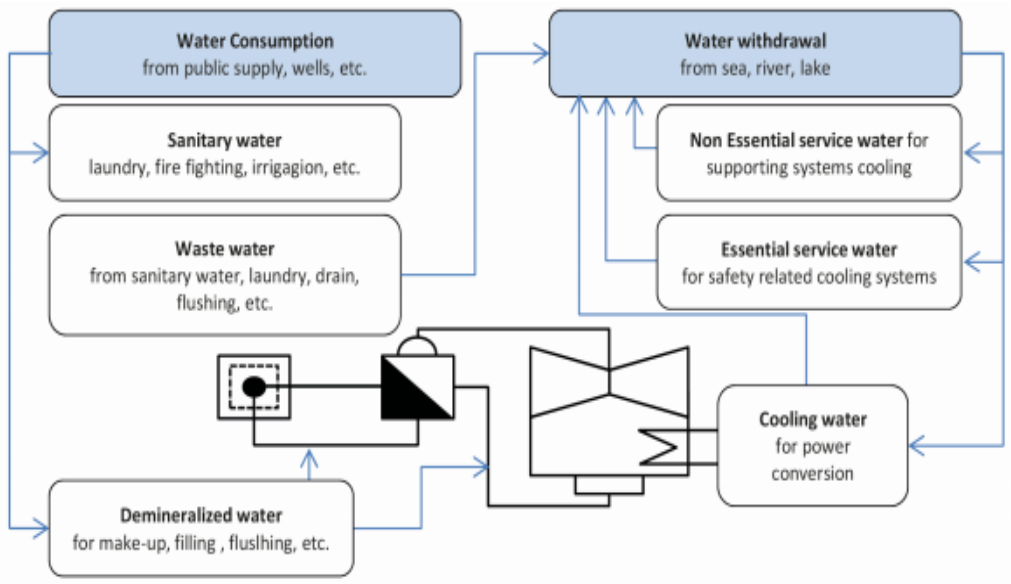

Figure 6-2: Water Streams in an NPP regarding consumption and withdrawal for open loop cooling system
Source: (IAEA, 2012) (No. NP-T-2.6)

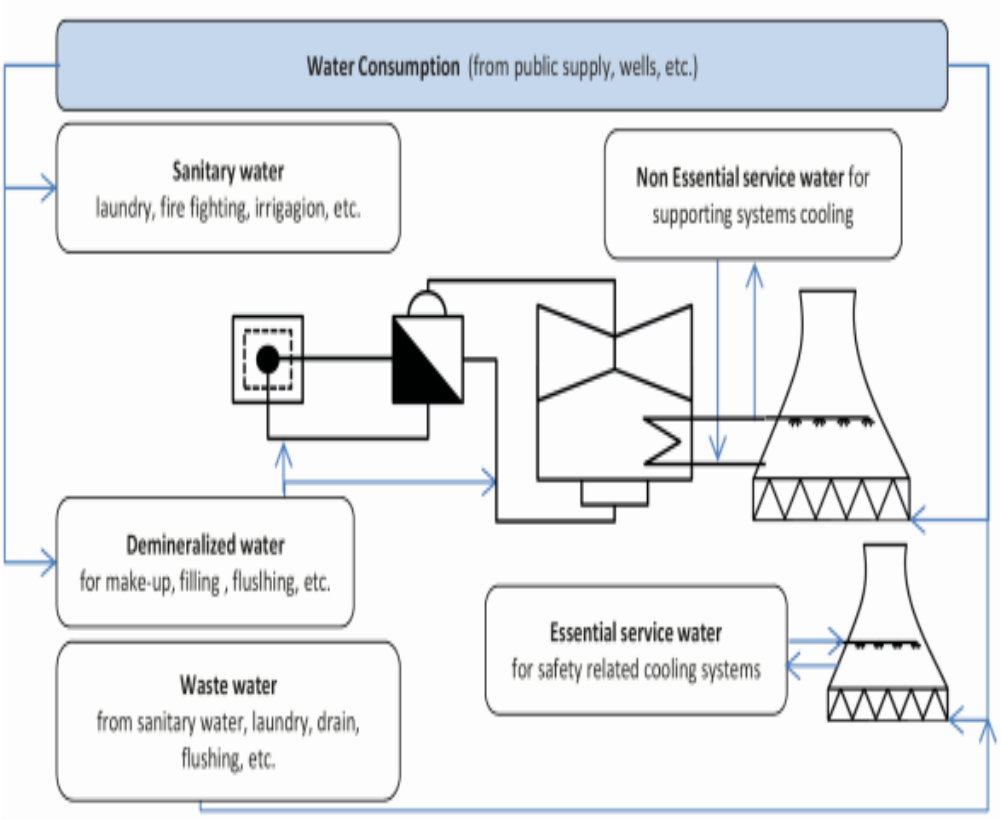

Figure 6-3: Water Streams in an NPP regarding consumption and withdrawal for closed cooling system
Source: (IAEA, 2012) (No. NP-T-2.6)

Water needs during the construction phase of a nuclear reactor are mostly satisfied by regular water. Water is needed for concrete mixing, backfill moisture adjustment, dust control, potable water for construction personnel, initial fill of circulating water reservoirs, and pre-operational flushing and testing. IAEA approximate the water needs during construction for a period of 4-5 years as adopted from: IAEA Nuclear Energy Series Technical Reports: Efficient Water Management in Water Cooled Reactors No. NP-T-2., are as follows

- 10 000 to 40 000 m^3 during excavation depending on site characteristics.
- 70 000 to 120 000 m^3 for concrete mixing.
- 300 000 to 600 000 m^3 supply for the construction staff depending on the site.

The predominant water use at a nuclear power plant is in the cooling system required to remove the heat rejected in the condenser after the power conversion. The quantity of water used for condenser cooling is a function of several factors, including the capacity rating of the plant and the increase in cooling water temperature from the intake to the discharge as shown in **Figure 6-4** below. Additionally, the necessity to clean the cooling water before being used in the plant increases the total water use, as a portion of it is used for discharging the debris and cannot be used for cooling. The larger the plant, the greater the quantity of waste heat to be dissipated, and the greater the quantity of cooling water required.

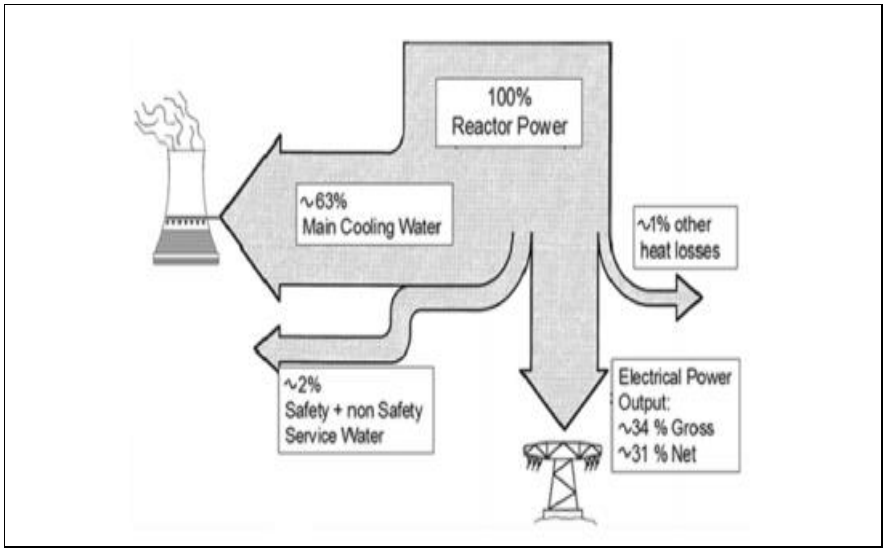

Figure 6-4: Energy conversion and heat dissipation during operation at full load
Source: (IAEA, 2012) (No. NP-T-2.6)

The water required for cooling the turbine condenser depends strongly on the site conditions and location of the plant. To achieve a high performance, the site selection considers cooling water sources with the lowest possible water temperatures, which also might allow a higher heat up range (respecting local aquatic life). The more heating up of the cooling water is allowed, the less cooling water flow is required. Further reduction of water withdrawal from the river/lake is possible, if hybrid cooling systems are used. Currently, the candidate sites under consideration are The Coastline (Lower Tana River Basin, Lamu area), the Lake Victoria Basin and the Lake Turkana Basin. These basins have been undergoing transformation over years due to a number of factors, anthropogenic pressure being a key factor. The Table 6-1: Environmental issues at the candidate sites below gives a summary of their significance and the current issues:

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Table 6-1: Environmental issues at the candidate sites

Basin	Current Issues
Coastline: The Lower Tana River Basin	• Projects being implemented are done in an ad-hoc way, independently of each other hence overlooking the cumulative impacts of these projects on the sum-total ability of the basin's ecosystem services. • The projects have been undergoing independent Environmental Impact Assessments without subjecting all PPPs along the basin to a Strategic Environmental Assessment • *Competing Water Demands* - there is a strong competition for water resources among many different actors: irrigation, fishing, horticulture, rice production, hydropower, domestic water use, and drinking water supply for major towns. • *Extreme Weather Fluctuations* - climate change is expected in the long-term to increase the rainfall in the basin, but with increased extremes including drought. Floods and droughts have displaced populations within the basin; the East African region is likely to have an increase in mean annual precipitation during the rainy season alongside frequent and extreme droughts during the dry season (IPCC, 2007). • *Downstream Impacts* - impacts of dam construction upstream (providing 60% of Kenya's electricity) on the downstream ecosystem and populations. There is an urgent need to maintain instream flows and the natural flooding regime of the Tana to support dry season grazing, fisheries, floodplain agriculture and the various water-dependent natural ecosystems (such as forests, wetlands and mangroves) vital to local livelihoods.
The Coastline: Lamu Basin	• *Eutrophication:* Inputs of nutrients to coastal areas from waste treatment facilities, nonpoint sources in watersheds (such as from agriculture), and the atmosphere • *Habitat modification:* Undertaking of infrastructural projects at the coastal line which involve dredging, mangrove clearance tends to modify the ecosystem • *Relative severity of threat to coastal and coral resources.* In Kenya's coastal regions, human activity has taken its toll. In a ranking of the world's most diverse and most threatened reef habitats, Kenya's reefs appear – highlighted in red to indicate the highest level of threat. • *Exploitation of resources:* Kenya's fishing industry is comprised largely of artisanal and small-scale fisheries; nevertheless, the fisheries close to the coast are overexploited, due to increasing numbers of fishermen and to the destructive practices, including fine mesh nets, uncontrolled spearfishing, and weighted seine nets. Farther out, trawlers from China, Japan, and South Korea are increasingly fishing Kenya's marine resources. ○ Mangroves in Kenya are cleared for subsistence activities, some shrimp aquaculture, and salt production. The larger patches of remaining mangroves are found round the Kiunga Marine Reserve, near Lamu, from Diani to Shimoni, and near Kilifi. ○ Thousands of tourists, many from wealthy European countries, also visit the coasts every year. These visitors, while welcomed for the revenue they bring, demand resort-quality treatment during their stay, which requires higher consumption of water, energy, and other resources, and creates greater amounts of wastes, in the already underserved coastal areas. • *Toxic effects:* This is contributed by the deep-sea waste disposal, pollution from agro-chemicals, effluent discharge etc. • *Global climate change and variability* • *Shoreline erosion and hazardous storms* • *Pathogens and toxins affecting human health* • *Isolated Watershed studies:* Lack of a coordinated governmental and donor agencies activities and research of watershed management increases the potential inherent in this threat.
The Lake Victoria Basin and the	• Hinterlands have experienced exponential growth in populations and their activities altering the environment and the natural resource base. The problems experienced are associated with population pressure, greater urbanization, industrialization, intensified agriculture, over grazing, deforestation, wetlands destruction, soil erosion and greater use of pesticides.

Basin	Current Issues
Rift Valley Water Basins	• Due to increased population, the hinterland is dependent on the lake - overexploitation and pollution alike have become a major challenge. Within the basin, increased development activities, occasioned by population pressure and associated with greater urbanization, industrialization, intensified agriculture, over grazing, deforestation, wetlands destruction, soil erosion and greater use of agrochemicals, lead to discharge of nutrients and other wastes generated causing changes in the lake ecosystem. Massive algal blooms have developed, water borne diseases increased in frequency and water hyacinth started choking important waterways and docking beaches. • *Lack of routine monitoring/observation*: Isolated studies had been done but deterioration in the lakes' water quality had not been adequately established and quantified. There had been no established water quality criteria on biological, physical and chemical aspects for the improvement of the water quality. Data collection network had been inadequate and decreasing. There had been lack of information on the levels of pollution from diffuse sources and urban surface run off e.g. residual agro-chemicals and pollutants from Urban Surface run off. Holistic ecosystem management approach was not possible based on the limited data available and the capacity of the region to provide the necessary information. • *Inadequate Capacity:* there was inadequate capacity in terms of collaboration and equipment, which could be used for field monitoring and laboratory analytical requirements. Recurrent funding for operating the existing monitoring networks were always insufficient and field installations were not maintained. • *Conceptual model:* Despite attempts to develop Water Quality models, no models have been developed, calibrated or validated for the Lake to guide ecosystem management and to explore options for restoration.
Lake Turkana Basin	• *Habitat degradation*—especially by damming of the Omo River and irrigation in the Omo Valley, biodiversity loss, pollution, tribal conflicts and climate change. Heavy grazing along the lower Omo valley, especially along watering routes and settlement close to the rivers contributes to pollution by human and livestock waste. These concerns could potentially be heightened by development of oil resources, especially along the western shores of the lake. In addition, about 150,000-200,000 hectares of woodland in southern Ethiopia are cleared annually for wood fuel, exposing soils to strong winds which causes siltation of the lake. • *Ecosystem fluctuations* - associated with climate change and human activities within the basin have caused biodiversity loss, especially endangering tiger fish and minnows within the lake. • *Drought:* The water balance and fisheries of the lake are highly sensitive to rainfall and drought, and this is expected to worsen with intensification of climate change. This is exacerbated by the use of water for irrigation in the Omo river valley. Construction of a hydropower dam and the large irrigation scheme in the Omo valley are expected to cause a drop-in lake level by 20 m since 90 % of its water comes from the Omo River. • *Invasive Species:* An introduced weed *Prosopis juliflora*, which is toxic to animals and highly invasive, creates dense and impenetrable thickets, making the shores inaccessible, is a threat to the lake.

Source: (SGS, 2019)

6.2.5 Nuclear Power activities' potential for ground water contamination

Groundwater exists as an integral part of the larger hydrological cycle of a given region. Interactions between groundwater and surface water bodies (recharge and discharge zones) provide one of the major pathways through which groundwater contaminants interact with humans and the wider terrestrial environment. These interactions can be beneficial by diluting the contaminated groundwater. Examination of various groundwater contamination scenarios is important for assessing the magnitude of the problem and changes expected to occur over time, and for selecting applicable remediation technologies and strategic approaches.

In Nuclear Power Programmes, IAEA has identified possible sources for ground water contamination as listed below: -

- The discharge of liquid wastes into infiltration pits or ponds, or into aquifers using injection wells;
- Inadvertent releases, spills or leaks of liquid wastes;
- The leaching of contaminants from radioactive material deposited on exposed surfaces by fallout;
- Wastes stored or disposed of in surface or subsurface facilities; or
- Alterations of groundwater characteristics which may mobilize materials or species previously retained as solid phases or absorbed to the aquifer matrix.

In the first two cases above the liquids are likely to be aqueous. In cases where the liquids are partially or completely composed of immiscible fluids, multiphase flow will have to be considered in assessing the overall extent of the environmental problem. In the case of solid waste sources, contamination with radionuclides can be direct (the contaminants are leached from the stored solid materials or escape from incompletely contained or immobilized liquids) or indirect (contaminants are mobilized by chemical processes in the leachate). Indirect radionuclide mobilization can occur as a result of reactions in the waste that change pH and/or electrical conductivity, increase the concentration of complexing agents or competing ions, or provide colloid forming materials in pore fluids in the waste. Table 6-2: Classification of Aquifers in Kenya below shows aquifer classification in Kenya.

Table 6-2: Classification of Aquifers in Kenya

Class	Description	Examples
Strategic aquifer	Aquifer used to supply significant amounts/ proportions of water in a given area and for which there are no available alternative resources, or where such resources would take time and money to develop; significant trans-boundary aquifers	Sabaki, Tiwi, Nairobi, Central Merti, Nakuru, Kabatini, Lake Naivasha Lamu Island
Major aquifer	High-yield aquifer systems with good quality water.	Daua and Elgon volcanics
Minor aquifer	Moderate-yield aquifer systems with variable water quality.	Mandera Jurassics
Poor aquifer	Low- to negligible-yield aquifer systems with moderate to poor water quality.	Basement System
Special aquifer	Aquifer systems designated as such by WRMA	Isinya

Source: National Water Master Plan report 1992

In case of any contamination, aquifer monitoring will be required to prevent the site from nuclear contamination. Since the Turkana Basin is one of the potential region/ candidate site,

it is thus prudent that conceptual models for remediation and legal and institutional controls be put in place as a pro-active management strategy.

6.2.6 Impacts from NPP Decommissioning

One of the critical issues for a nuclear power plant is decommissioning. This complex process requires a dedicated EIA report, treatment or disposal of contaminated facility materials and monitoring of the situation until release from regulatory control. Since decommissioning may happen 100 years after the start of operation, it is not addressed in detail in the EIA report for construction and operation of a plant, but it is described in principle, with the currently available possibilities for decommissioning. In Kenya decommissioning EIAs are not often done and therefore this culture may present a challenge will need to be emphasized in the regulatory structure.

Owing to the international and public attention given to the potential impacts of a nuclear power plant project (both radiological and non-radiological), Kenya will need to spend significantly more resources and time on EIAs relating to nuclear power plant projects than those associated with other industries as required in the Nuclear Regulatory Act, 2019.

6.3 Socio-Economic Impacts of Nuclear Power Programme

This section outlines the socio-economic information and impacts/concerns of the nuclear sector policies, plans and programmes across the proposed NPP. More impacts are discussed below.

6.3.1 Employment Impacts and Population Migrations/ Influx Management

All forms of power projects, just like nuclear, bring employment benefits, although they will differ in skill sets and distribution (both by sector and geography) for different technologies. As such, it is difficult to assess the net employment benefits or community impacts for one technology in isolation. For example, in the United Kingdom approximately 40,000 people are directly employed by the UK nuclear industry, with almost the same number indirectly dependent upon it. About 20,000 people are said to be involved in the production, reprocessing and storage of nuclear fuel, with 15,000 people employed in the operation and decommissioning of plants (Cogent 2005). Many of the jobs are high skilled, well paid and often in areas where alternative employment opportunities are low. Job losses from plant closure can be partly offset by decommissioning employment although economic activity in the local area will eventually decline.

The siting, construction and operation of such a programme has both positive and negative impacts on the local economy. One of the primary local benefits for communities in the vicinity of a nuclear plant, is the creation of local jobs and the direct impacts of salary payments, business taxes and capital expenditure that come with employment. There may also be positive indirect impacts such as the development of local supply chains or improvements to infrastructure due to increased demand for the services. The significance of the employment impact will depend on the workforce catchment area, the proportion of locals employed, the skills requirements and the balance of job retention against job creation. The influx of skilled workers and their families to the local community can create social and cultural tensions and pressure upon local services and infrastructure. There is a societal trade-off between the benefits of local employment from nuclear power and the perceived negative image that deters alternative investment. In small communities with a less diverse economic base, the employment effects of a nuclear plant can be significant.

Case Study

A study in the UK revealed that:

The UK company British Energy directly creates 4,900 jobs, most of which are at their eight nuclear plants and an estimated 12,700 indirect and induced jobs. Similarly, BNFL plc employs 23,000 people as a group, 16,000 in the UK mostly in the vicinity of its plants. Its Nuclear Sciences and Technology Services (Nexia) and Spent Fuel Services (SFS) employ 900 and 494 people respectively, with Westinghouse Electric providing 7,600 jobs worldwide. Its older Magnox fleet employ, or have employed, on average 350 workers. On a local scale, studies have indicated 5,000 jobs have been safeguarded in West Cumbria over the past six years as a result of BNFL community investment. At the peak of its operations in the early 1990s, the Sellafield site employed

Notwithstanding, measuring the net employment impact of a new nuclear programme need to take account of any substitution effect. This refers to employment that might have been created in alternative technologies and industries but which investment in nuclear plant could displace. Essentially, there is an upper limit to the need for new electricity generating capacity, and each potential technology and industry would create some employment through meeting it.

With increased opportunities in the candidate areas, it is expected that the migration of persons to these areas in search of greener pastures will go up especially as the number of unemployed and underemployed youth in the country is high. The areas should therefore brace themselves for an increase in resource strains including housing and water. This will also lead to human health and sanitation concerns. Further, employment opportunities are expected to be shared with people from other Counties in the country.

6.3.2 Preservation of Historical, Cultural Resources and Heritage Sites

It is observed that there are currently no guidelines and procedures for undertaking Heritage Impact Assessments (HIAs) and audits to guide the infrastructural developments operations in Kenya. In addition, there is inadequate professional skills in heritage resource identification, mapping, preservation and protection to cover the whole country and in particular at the County levels. There are also numerous heritage resources and in particular, sacred sites that are currently community controlled that require official mapping, regulation and protection by the national government. The UNESCO listed sites likely to be affected depending on the choice of the candidate sites are (details about these sites are in the Baseline Information Chapter):

- Thimlich Ohinga Archaeological Site situated within the Lake Victoria Basin
- Lake Turkana Basin
- The Fort Jesus along the coastline
- The Lamu Old town along the coastline

Notably, KNPP candidate sites are mostly situated in areas/ counties that have groups and communities listed as vulnerable and marginalized. This include:

1. The lake Turkana Basin
    - Turkana County: Turkans
    - Marsabit County: Gabra, Borana, Rendile, Samburu, Sakuye. and Desenach
    - Samburu County: Samburus, Pokots

1. The Indian Ocean Counties
    - Tana River County: Waata, Awer, Wailwana, Malakote and Bajuni
    - Lamu County: Bajuni, Awer, Somali and Ilwani.
    - Mombasa County: Swahili
    - Kilifi County: Waata and Swahili

- Kwale County: Waata, Wakifundifundi, Washayu Watwaka/ Wachwaka and Duruma

6.3.3 Gender and Equity

The Constitution of Kenya 2010 article 27(8) and the National Gender and Equality Commission Act 2011 clause 7(b) provide the legal basis for gender mainstreaming in all sectors and spheres in the country. It is however recognized that the implementation procedures and guidelines to realise gender equality and equity as envisaged in the relevant laws are largely inadequate. In Kenya, gender inequalities persist across many areas of development, particularly in employment, poverty, reproductive health, political participation and the fulfilment of human rights. For instance, except for female students' enrolment in universities that currently stands at about 35 per cent, in almost all other crucial development sectors women have a representation of less than the constitution threshold of 33 per cent. For this reason, it is anticipated that gender inequality is likely to be perpetuated particularly in the nuclear sector labour market and supply chains. Many traditions in Kenya, for instance, do not regard women as holding equal rights to men with regard to ownership of land, access to education, and a share in compensation for family property. It therefore means that women are likely to be further marginalised in terms of opportunities for education and training in the nuclear power programme and to be excluded from sharing in compensation for land acquired for the development of infrastructure. It observed that in instances where traditional cultural values and practices inhibit the access of women and even persons with disabilities to opportunities, there are no mechanisms to enforce legal and industry equity standards.

Gender interest representatives have also pointed out that there are no specific training and skills development programmes to meet the needs of women who are currently underrepresented in the national workforce. Further, the obligation to provide a quota of not less than a third of positions in public sector organizations are not often applicable to the private sector.

It is also observed that high population influx into the candidate sites has the potential to expose women and girls to sexual and economic exploitation. The increase in movement of populations to areas with nuclear power developments are also likely to increase incidents of abandoned or neglected wives, partners and children as new relationships are built and old ones are broken.

6.3.4 Human Rights

The Constitution of Kenya, 2010 has elaborate provisions for the recognition, protection and respect for human rights and fundamental freedoms with the aim of preserving the dignity of individuals and communities as well as the promotion of social justice (Article 19 paragraph 2 of the Kenyan Constitution 2010). Due to the pervasive nature of human rights and the potential for emergence of extensive networks of partners and suppliers in nuclear power sector, there is a wide scope for ambiguity as to which agency bears the duty to respect, promote and protect human rights in every specific situation.

It is noted, for example, that prior to the coming into force of the Right to Information Act 2016, the practice was that contract information management between the national government and multinational companies in infrastructural development excluded information sharing with the County governments in areas of projects' operation. In the same way, agreements between local community leaders and the multi-national development companies are never fully disclosed to all the concerned stakeholders within the local communities. Likewise, decisions on siting of development infrastructure and assets tend to be taken by the state with minimum consultations taking place mostly at the stage of land acquisition negotiations. Other potential rights challenges have been noted with regard to displacement of people to give room to infrastructural development. There is a concern that without the operationalization of the Evictions, Resettlement and Rehabilitation Bill of 2014, there is potential for violations of

human rights in the process of undertaking evictions to create room development of infrastructure of national interest.

Further, it is observed that the traditional approach to security management in Kenya prevents procedures for public access to security related information. Due to existing public perception on Nuclear Power Programmes' safety and security due to its inherent nature, it would be prudent to undertake information awareness campaigns for assurance on transparency and accountability of Nuclear Power operations. Members of the local communities in candidate areas and the public in general have often expressed concerns about inadequate information and guidance on the human rights redress mechanisms and procedures in infrastructural development. This situation tends to encourage attempts and threats by communities to attack developments sites and interfere with site operations on the basis of unresolved grievances.

As a right to information to the public about infrastructural development, it would therefore be prudent to come up with a stakeholder involvement and public consultation system for the NPP through its life cycles with a well-integrated feedback and monitoring mechanism.

The ethical debate of nuclear power programmes is primarily based upon its pros and cons, the environmental and soci0-econmic impacts in the society as discussed in this report.

6.3.5 Local Livelihood and Community Development

Energy infrastructure development and operations have potential environmental and social impacts on the societies of host countries, regions and communities. These impacts can be direct and indirect; intended and unintended; positive and negative; cumulative and non-cumulative.

Adoption of nuclear power and its injection into the national grid in Kenya is bound to impact and trigger a wide range of socio-economic changes in the country in general. The wide range of current and future energy developments and operations therefore necessitate a critical understanding of the current state of events and the necessary adjustments in policies and strategies to adapt and prepare for future developments in the sector.

The current experience in regard to mega infrastructure development is that, the multi-national contracted companies achieve these communality enhancement objectives through policies on employing qualified members of local communities and localisation of some roles. In addition to skills development and employment, these companies may also provide on voluntary basis support for infrastructure like roads and services in the fields of education and healthcare to local communities as is the case in oil exploration in Northern Kenya. The fundamental gap, however, remains the policy development to commit the governments at County and national levels to partner and provide budgetary support for these services in given underserved areas of operation.

For development of buffer zones, IAEA recommends that through their guidance, countries need to develop the safety distance guidelines. Such large buffer zones would inevitably adversely affect access to these vital resources necessary for the survival of the communities if they draw their livelihood thereof. Below is a guiding chart developed by EIEA on emergency planning.

Facilities	PAZ radius	UPZ radius	FRPZ radius
Reactors > 1000MW (th)	3 – 5 km	25 km	300 km
Reactors > 100 - 1000MW (th)	0.5 -3 km	5 – 25 km	50 - 300 km

Figure 6-5: Nuclear Power Emergency Planning Zones
Source: EU, 2008

Key

PAZ- Precautionary Action Zone: - A zone within a radius of about 5 km from a nuclear facility. Evacuation from this zone is conducted preventively before radioactive materials are released from the facility.

UPZ- Urgent Protective Action Planning Zone: - A zone outside of PAZ and in a radius of about 30 km from a nuclear facility. Sheltering, evacuation, and/or temporary relocation, as well as preventive protective measures, are conducted.

FRPZ- Food Restriction Planning Zone: - This is an area around the facility where preparations for effective implementation of protective actions to reduce the long term dose, i.e. the risk of stochastic

6.3.6 Public Perception and Consultation on Nuclear Power Programmes

Nuclear public perceptions vary from one country to another. There is a strong correlation between the concerns of the public and the lack of information about radioactive waste. The concerns are larger in the areas where the information is inadequate or insufficient. Documentation all over the world on perceptions of the public and attitude towards Nuclear Power Programmes has been done.

In Kenya, Mberia 2014, assessed the perceptions of the public and factors likely to reduce negative perceptions on nuclear power generation in Kenya. She concluded that availing of information about the nuclear power generation is likely to reduce negative perceptions as well as government actions to address the concerns.

NRC 2002, documents public perceptions in the world on Nuclear Power Programmes. In the Czech Republic, nuclear sector understands that the relationships and the communication with the public are the most important factors of its acceptance. There is distrust on the part of the public that don't have adequate information on the theme, and if they are threatened by the same or don't understand it, this fraction of the population most of the times harmonizes with antinuclear civil organizations that know exactly how to communicate with the public. The authorities consider it vital that the public relationships sector of the nuclear programme must achieve a more significant role in the future, compared with the current days. Fundamental factors for this conclusion are the constant change of information, trust, tolerance, and understanding, among other factors. Public visits are also considered necessary.

Authorities and agencies within the line industry are therefore obliged to supply information systematically about its operation, future plans and business activities for the citizens and organizations. The committee of the citizens' safety, whose partners are the representatives of villages, public in general and the state administration, that have access to the nuclear power plant, should participate in all the important negotiations and in the investigations of operational events and safety.

In the United Kingdom, the public acceptance for the construction of a repository is considered essential, but difficult to be obtained due to the uncertainties and inherent risks to nuclear power programme, and also the distrust associated with the same. The British authorities recognized that there is no uniform public perception, and it changes as time goes by. Frankness and transparency were recognized as some of the necessary mechanisms to obtain trust. They have in experience demonstrated that the strategy of 'decide, announce and defend' is not valid, and to overcome the problem of local acceptability, they suggest compensation measures, that would help to achieve acceptance.

Article 69(1)(d) of the Kenyan Constitution 2010 provides for public participation in the management and conservation of the environment and natural resources. The principal objective of public participation is to ensure that there is accountability, legitimacy, openness and transparency in policy formulation and implementation in the Nuclear Power sector. However, like with other laws and policies on public participation, there are inadequate guidelines to facilitate meaningful and informed public participation. Further, civil society organizations have expressed concerns that the majority of citizens have limited or no capacity to participate effectively in reviewing EIA reports and to monitor projects for compliance with licensing conditions.

There are also concerns that attempts to establish effective public participation is often undermined by the numerous and divergent interest groups that tend to claim to represent the genuine interests of communities. Some of the interest groups that may not share the same perspective and may claim to be the genuine voice of the local communities are professional groups, business communities, elected leaders, religious leaders, local administration and occupational groups like herders, fisher folk and farmers. There are also no specific local consultation procedures to harmonize or reconcile the often numerous and competing interests and perspectives.

6.3.7 Security Concerns on Nuclear Power Programme

Security concerns have taken centre stage in both the government and private sector circles since the August 1998 United States Embassy bombing in Nairobi's Central Business District that killed 213 and injured over 4,000 people. The attack adversely threatened security impacting on business development and economic growth. Although the 1998 attacks were directed at the American Embassy, the vast majority of casualties were local citizens with losses to property.

Due to the increased execution of terrorism related incidents and other forms of violent crimes mainly in Nairobi, Rift Valley, Northern, North Eastern, Lamu and Mombasa in the Coast region, the energy industry being a multi-billion sector, has resulted in stakeholders becoming more alert to the need for effective mechanisms that assure Kenya's and the East Africa region's energy security. The security issue is also of importance since a number of insecurity incidents/post-election violence have been recorded in Kenya's prospective candidate basins. It is of importance to note that the nuclear power programme which is a capital intensive industry attracts foreign investments and large extents expatriates who may become easy target to the terrorism (ransom) activities. In addition, nuclear facilities as vital installations that require adequate security management and intelligence to ensure they are safeguarded. Any attack to such a facility, is a huge threat to public health and the environment.

Concerns surrounding cyber warfare has gained attention in the international community, and it has now become a matter of concern for the nuclear industry as well. The consequences of a cyber-war are no less than those of a traditional war with the loss of money, lives, infrastructure, and national stability.
Three possible risk scenarios involving nuclear facilities are:

Cyber-attacks: which corrupt nuclear command and control systems and remove radioactive material. Such attacks can be executed if the facility has weak security controls and policies, and with the involvement of an insider. The sophistication of these attacks demands identification of vulnerabilities, expertise in industrial Control System, and the creation of malicious programmes. Assessment of Cyber Security Challenges in Nuclear Power Plants ascertains that Terrorist groups are unlikely to have access to such expertise or resources, but military nation states might have such capabilities to execute attacks against another country.

Cyber sabotage: which affects the normal operations of a nuclear facility and causes serious damage to nuclear equipment. Sabotage can come in many forms: it could cause physical disruption to nuclear equipment, introduce viruses or malware into a system, or even plant malware that could result in nuclear explosion. The supply chain management cycle and procurement of third party software are also seriously threatened. History has witnessed a number of incidents, in which intentional or unintentional acts of deploying malicious software resulted in unrecoverable damage to a nation's infrastructure. Incidents which modified the Iranian vacuum pumps in 1990, planted explosive material in Iran's nuclear equipment in 2012, and altered cooling components in Iran's nuclear power reactor in 2014 are a few examples of cyber sabotage

Cyber espionage: the collection of confidential information from a nuclear facility and its usage for malicious purposes. Cyber espionage is more common than sabotage since this type of attack does not require as much technical expertise. There are many tools, such as key loggers and spyware, freely available on the internet, which could be remotely installed on a victim's computer to penetrate a trusted network and access sensitive information. The nuclear industry has been a target of cyber espionage since 1986; however, a new series of attacks began in 2005, when Chinese hackers penetrated U.S. military systems for nuclear secrets. In 2006, Israelis planted a Trojan Horse on Syrian computer systems and gained access to their secret nuclear programme. Similarly, in 2008, Russian forces created a malware named 'agent.btz' to hack the U.S. classified network. A number of attacks were launched from 2011 to 2013 on U.S. and IAEA sensitive facilities.

Incidents have made cyber security an ever increasing concern for nuclear facilities, including power plants and weapons facilities. This evolution in technology has also introduced vulnerabilities in and hacking attempts on nuclear systems. Software vulnerabilities have made it easy for hackers to steal sensitive information, spoof systems, or potentially damage critical nuclear facilities and processes. Such vulnerabilities could be introduced through bugs in software programmes or zero day exploits.

6.3.8 Key Economic Challenges, Impacts and Opportunities in the Nuclear Industry

The sector impacts the Kenyan economy in many ways such as employment, exchange rate, government revenues through taxation, stimulating infrastructure, consumption and production/manufacturing in the country. For instance, a well-developed and managed sector could help reduce the high youth unemployment, increased revenue and foreign direct investments reduce the strain on the exchange rate through increasing the foreign reserves and easing strain on the exchange rate of Kenyan shilling against major currencies through reduction of fuel import. However, there are challenges that could come from investing in the sector. Below is a detailed account of the challenges and opportunities in the sector.

6.3.8.1 Weapons proliferation and terrorism

With any proposed development or expansion of nuclear energy globally, nuclear weapons proliferation is a key concern that must be addressed. Today, there are also fears of the possibility of nuclear weapons reaching the hands of terrorist groups. Proliferation of enrichment or reprocessing capability may make it easier for terrorist groups to obtain highly enriched uranium or plutonium which, in theory, might be used to make small and unsophisticated but nonetheless horrific bombs. Finally, there is the spectre of terrorist groups attacking or attempting to sabotage nuclear power plants. Questions about proliferation are key owing the recent history and terrorism occurrences within Kenya and her neighbours. Coupled with legal gaps within the sector on its safety of operation, cyber security and possible sabotage at the profit of malicious users of nuclear material, proliferation has therefore the capacity to cripple the economy if tested, trusted systemic and human resource firewalls are not put in place.
A connection between nuclear power and nuclear weapons exists because both require fissile materials. Some of the technology that can be used to produce or purify a fissile material for a nuclear power plant could also be applied to producing nuclear weapons. There are three main fissile materials that are used in nuclear reactions:

- Uranium-233 (233U)
- Uranium-235 (235U)
- Plutonium-239 (239Pu)

In addition, Plutonium-240 (240Pu) and Plutonium-241 (241Pu) are produced and consumed in Nuclear Power production but neither can be used for Nuclear Weapons. Out of these three materials only 235U exists naturally as an isotope of natural uranium with concentrations of 0.7%. Plutonium-239 and Uranium-233 are created by neutron capture on 238U and Thorium-232 (232Th) respectively.

The proximity of Kenya to the war-torn Somalia, increases the risk of terrorism attacks due to Al-Shabaab's group alliance with the ISIS that poses a nuclear attack threat in the world. Lamu coastal line has been recipient of attacks by the insurgent group in the recent past, with attacks such as the Mpeketoni attack in June 2014, which would expose the NPP to possible attacks or make it an easy source, in case of sabotage or systemic administrative failure, for nuclear weaponry manufacturing material.

6.3.8.2 Human Resource Capacity

The performance of an industry reflects its technical and economic efficiency, but can also be assessed through the sector's capacity for anticipation and commitment. Such performance can only be attained through sufficient mastering of the production tools. This is looked at in a threefold factor: firstly, a capacity to design the production tools; then, an extensive knowledge of the suppliers and equipment that constitute these production tools; and, lastly but of prime importance, the return of experience (ROE) gained in operating these tools.

Nuclear technology is usually acquired from a more advanced country. For technology transfer to be successful, the recipient country must be capable of absorbing the technology, and the key to this is the availability of qualified manpower. In many developing countries, the need for nuclear scientists and research-oriented personnel has often been over-estimated, while the need for highly qualified and experienced practically-oriented engineers, technicians and craftsmen has been very much under-estimated. In most cases the major staffing problems have concerned engineers and technicians at all levels with practical experience for project execution and operation.

Technician education and training for nuclear power remains a difficult problem. In Kenya, none of the institutions of higher learning offers any Bachelors' course on nuclear energy as preparation to kicking off the programme in the Country. However, the University of Nairobi

offers a Masters' programme on Nuclear Science whose course content is fragmented across all disciplines relevant to nuclear science and thus does not fully equip students with the requisite knowledge which is a core aspect in NPPs both practically and theoretical.

6.3.8.3 Infrastructural Capacity

It is a requirement that the country builds the necessary infrastructure so as to construct and operate a Nuclear Power Plant (NPP) in a safe, secure and technically sound manner. A major part of the necessary infrastructure is the electric grid to which the NPP will be connected. While Kenya has and is already expanding its electric grid system, it may require significant enhancement/upgrading to be suitable for the connection of an NPP. The safe, secure and reliable operation of the NPP requires that the grid to which it is connected is also safe, secure and reliable. Interfacing NPPs with existing grids requires complex engineering. This complexity of engineered systems is a consequence of several factors: the sheer size and interconnectivity of the electric grid; the nuclear safety requirements imposed on NPPs; the need to balance electricity supply and consumption throughout the grid at all times; and the nature of electricity — that it is generated as it is consumed.

In addition to assuring that the electric grid will provide reliable off-site power to NPPs, there are other important factors to consider when a NPP unit will be the first to be connected to the grid and more important if it's a large unit. If the NPP is too large for the grid, the operators will face these challenges: -

a. Off-peak electricity demand might be too low for a large NPP to be operated in baseload mode, i.e. at constant full power.
b. There must be enough reserve generating capacity in the grid to ensure grid stability during the NPP's planned outages for refuelling and maintenance.
c. Any unexpected sudden disconnection of the NPP from an otherwise stable electric grid could trigger a severe imbalance between power generation and consumption causing a sudden reduction in grid frequency and voltage. This could even cascade into the collapse of the grid if additional power sources are not connected to the grid in time.

Kenya's current effective (grid connected) electricity capacity is 2,600MW. Electricity supply is predominantly sourced from hydro and geothermal sources. This generation energy mix comprises 52.1% from hydro, 32.5% from fossil fuels, 13.2% from geothermal, 1.8% from biogas cogeneration and 0.4% from wind, respectively. The current electricity demand is 1,600 MW and is projected to grow to 2,600-3600 MW by 2020 hence will need to be developed further to accommodate the project nuclear power injection.

6.3.8.4 Nuclear Power Programme Implementation and Operational Costs

Nuclear power plants are complex, as is the financing. It would be highly gratifying if simple and adequate financing could be found which would be readily applicable and acceptable for nuclear power plants that would satisfy the investors/ operators, the Government, the financing institutions and the suppliers of goods and services.
From the financing point of view, nuclear plants have some special features that should be considered. The principal ones are:

- Large investment.
- Long lead and construction times.
- Complex technology.
- Regulatory risk; and

Nuclear plants are capital-intensive compared with alternative energy sources. Fossil-fuelled electricity generating plants (coal, oil, gas) producing an equivalent amount of electricity, are less expensive to build. Gas-fuelled plants in particular, are much less expensive alternatives. Hydroelectric plants also tend to be capital-intensive, except where very favourable site

conditions lead to relatively low costs. However, on most such sites, hydroelectric projects already exist, so new projects tend to be more expensive, often costing more than nuclear plants. As to the renewable options (wind, solar, biomass, etc.), costs to produce equivalent amounts of energy are, as a rule, considerably higher than for nuclear plants.

A long period of time is required for practically all stages of nuclear power project planning and implementation. Relatively long construction times have a major impact on overall capital requirements, which must be financed before the plant produces electricity and before there are revenues. There are also risks of delays and cost-overruns, usually perceived as greater for nuclear projects then for fossil-fuelled alternatives.

In its complex nature, its engineering and management and the supply industry in general are complex too. It thrives where there can be no compromise on quality and safety considerations. The industry is very dynamic in technology, requires extensive research, development, and testing before they can be implementation. And even with all precautions, technological problems may arise with impacts on economics. All this implies technological risks. To assure nuclear safety to protect the public and plant personnel, nuclear power plants functions should be in a highly dynamic regulated environment. This has economic and financial implications. It constantly evolves and tends to become more stringent, setting more and more demanding goals and conditions to be met. This constitutes a regulatory risk that can lead to delays in construction, changes, modifications, and corresponding additional costs.

Globally, politics and nuclear power are inseparable. National and international politics affect nuclear power, and eventual changes from the conditions prevailing when a nuclear project is launched and financing is committed, constituting what might be called a "political risk". International politics may affect the market in nuclear technology, fuel, materials, equipment and components as well as cooperation between countries and can have serious consequences for countries dependent on foreign supply. The influence of national politics on nuclear power presents possibly an even greater risk. The local context of government regimes is on a five-year term, hence do not last forever, and when they change, new governments may have differing views of the key areas of development, and may implement corresponding policies which may or may not be in favour with the Nuclear Power Programme. Global experience is that national politics tend to respond to public perception and media attitude regarding the nuclear issue and these may also change.

The final challenge towards costs and financing of the Nuclear Energy Power Programmes as set by IAEA which Kenya ought to meet, cognizance of the national public external debt, include: -

- National policy supporting nuclear power.
- Creditworthiness.
- Economic competitiveness.
- Project feasibility.
- Assurance of adequate revenues.
- Acceptability of risks; and
- No open-ended liabilities.

6.4 Occupational Safety and Health in Nuclear Power Sector

The following chapter broadly presents the Occupational Safety and Health (OSH) concerns in the nuclear power programme Kenya. It also incorporates concerns of the NPP based on consultations with relevant stakeholders, field case studies and relevant literature available. Local statutes, regulations and standards currently in place supplemented with international standards and policies applicable to the sector are discussed herein. The role of management on safety and health in NPP occupies a systematically integrated and well-structured approach. This system has stringent standards, guidelines and international legal structure

developed by international multi-agency in the atomic energy headed by IAEA. The development of the Nuclear Power sectors in Kenya will present significant new challenges in the management of Occupational Safety and Health to the implementing line agency (ies), the Directorate of Occupational Safety and Health Services (DOSHS), under the Ministry of Labour and East African Affairs.

6.4.1 Health Impacts of Nuclear Power Programmes

An exploration of nuclear energy impacts on health is complicated by several factors. First, scientific understanding of the translation of health risks into effects is not complete. Second, compared to other forms of energy, nuclear energy is surrounded by a highly complex web of political, economic, environmental, safety and other issues. An examination of impacts on health cannot ignore the context formed by, and values linked to, many of the above factors. Third, discussions of health impacts can be quickly disputed. Epidemiological studies that indicate one result or another may become irrefutable evidence in the minds of advocates on either side of the nuclear energy debate (Martin & Harbison, 1996). Nonetheless, the operations and materials normally associated with the production of nuclear energy pose numerous health risks, which can be broadly categorized as radiological and non-radiological in nature.

Radiological health risks: arise from the presence of materials that emit radiation at each stage in the nuclear fuel cycle. Radiation exposure can also happen in case of nuclear accidents. Of concern are materials that emit gamma rays, alpha particles, beta particles and neutrons. Gamma radiation, alpha particles and beta particles are forms of ionizing radiation energetic enough to break chemical bonds in living cells, which can be very detrimental to human health. Neutrons, while not directly ionizing, are very penetrating and can impart considerable energy to human tissue. When ingested or inhaled, radioactive materials pose particularly significant risks, since they easily cause tissue and other damage from within the body. Depending on factors such as total dose, dose rate, whole body vs. partial body irradiation, internal vs. external exposure, age at exposure, and the nature of radiation in question, the health effects that may arise from radiation exposure include various forms of radiation sickness, thyroid disease, numerous cancers, long-term health problems, genetic effects that can manifest themselves in future generations, and death.

Non-Radiological health risks: Throughout the nuclear fuel cycle, many activities require the use of heavy machinery and equipment, hazardous chemicals, and large, complex facilities. The non-radiological health risks posed by such activities are similar to those expected in any large-scale industrial endeavour. For example, just as in any industrial endeavour, fuel cycle activities have given rise to physical injury from faulty machinery, the careless operation of equipment, fires and explosions. Physical injury, illness and cancer are effects that may arise from inadvertent exposure to chemicals and materials used in fuel cycle activities. Uranium-238, for example, which is ubiquitous in the fuel cycle, is toxic and has been shown to impair kidney function in humans when ingested.

Radiological and non-radiological health risks associated with nuclear accidents and with the misuse or unauthorized use of nuclear materials and facilities: As demonstrated in 1986 at Chernobyl, nuclear plant accidents can result in the release and dispersion of large quantities of radioactive materials hazardous to human health into the environment. High levels of radiation exposure to workers and members of the public can ensue, causing acute radiation effects and death. Beyond the health effects arising from radiation exposure, physical injury to workers can result from an accident, and an accident may create panic in populations and lead to physical injuries and even loss of lives. Perhaps the greatest possible health impact that could arise from nuclear energy is the clandestine development and use of nuclear weapons by a nation using materials that have been diverted from civilian nuclear energy facilities.

Psychological health impacts: these relate to mental health. Normal operations and accidents pose psychological risks to workers and members of the public. Psychological impacts from nuclear energy risks may arise because: -

- Radiation is invisible, tasteless, odourless and generally intangible and
- It is not uncommon for the potential consequences of nuclear energy accidents to be equated with the effects of nuclear weapons.

According to this perspective, public fear of being unable to detect and avoid radiation and the fear of Chernobyl-like consequences of nuclear industry accidents may lead to feelings of anxiety and dread among members of communities near nuclear installations.

This calls for policy makers to consider entrenchment of Health Impact Assessment (HIA) in the EIA process in the country. HIA is a means of assessing the health impacts of policies, plans, programmes and projects in diverse economic sectors using quantitative, qualitative and participatory techniques. HIA helps decision-makers make choices about alternatives and improvements to prevent disease/injury and to actively promote health, which is one of the goals of sustainable development. The World Health Organisation (WHO) supports tools and initiatives in HIA to dynamically improve health and wellbeing across sectors. A well-executed HIA can prevent new projects delays by anticipating, soliciting and appropriately incorporating stakeholder concerns and suggestions into the overall project design as a way of mitigating the project-health anticipated impacts. Similarly, existing operations can also benefit by the timely assessment and evaluation of a broad range of impacts. One of the key benefits of the HIA process for stakeholders is the awareness that health is a relevant and significant cross-cutting issue.

6.4.2 General EHS impacts for the typical infrastructure

6.4.2.1 Noise Pollution

NPP development activities generate noise during all phases of development including, construction activities, and production, aerial surveys, road transportation. Noise sources, pumps, reactors, compressors, generators, and heaters.

Several measures to prevent and minimize noise are in place as presented in:

- The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 and,
- The Factories and Other Places of Work (Noise Prevention and Control) Rules 2005

The above two regulations provide for; permissible noise levels, noise prevention programme, applicable engineering controls to reduce noise limits, hearing protection, licensing, offenses and penalties. These can be appropriately supplemented by the globally IFC Environmental, Health, and Safety IFC general EHS guideline.

6.4.2.2 Terrestrial Impacts and Project Footprint

Project footprints resulting from construction activities may include, temporary facilities, such as workforce base camps, storage yards, workshops, access roads, and construction material and nuclear fuel extraction sites. Operational footprints may include permanent processing treatment, electricity transmission and storage facilities, electricity transmission right-of-way, access roads, ancillary facilities, communication facilities (e.g. antennas), etc. Impacts may include loss of, or damage to, terrestrial habitat, creation of barriers to wildlife movement, soil erosion, and disturbance to water bodies including possible sedimentation, the establishment of non-native invasive plant species and visual disturbance. The extent of the disturbance, which will be determined by independent individual project ESIAs, will depend on the activity along with the location and characteristics of the existing vegetation, topographic features and waterways.

6.4.2.3 Accidental radioactive emissions

First, the impact of nuclear accidents has been a topic of debate since the first nuclear reactors were constructed in 1954, and has been a key factor in public concern about nuclear facilities. Technical measures to reduce the risk of accidents or to minimize the amount of radioactivity released to the environment have been adopted, however human error remains, and "there have been many accidents with varying impacts as well near misses and incidents". As of 2014, there have been more than 100 serious nuclear accidents and incidents from the use of nuclear power. Fifty-seven accidents have occurred since the Chernobyl disaster, and about 60% of all nuclear-related accidents have occurred in the USA. Serious nuclear power plant accidents include the Fukushima Daiichi nuclear disaster (2011), Chernobyl disaster (1986), Three Mile Island accident (1979), and the SL-1 accident (1961). Nuclear power accidents can involve loss of life and large monetary costs for remediation work.

Soundly, the vulnerability of nuclear plants to deliberate attack is of concern in the area of nuclear safety and security. Nuclear power plants, civilian research reactors, certain naval fuel facilities, uranium enrichment plants, fuel fabrication plants, and even potentially uranium mines are vulnerable to attacks which could lead to widespread radioactive contamination. The attack threat is of several general types: commando-like ground-based attacks on equipment which if disabled could lead to a reactor core meltdown or widespread dispersal of radioactivity; and external attacks such as an aircraft crash into a reactor complex, or cyber-attacks. For example, The United States 9/11 Commission found that nuclear power plants were potential targets originally considered for the September 11, 2001 attacks. If terrorist groups could sufficiently damage safety systems to cause a core meltdown at a nuclear power plant, and/or sufficiently damage spent fuel pools, such an attack could lead to widespread radioactive contamination.

Nuclear reactors become preferred targets during military conflict and, over the past three decades, have been repeatedly attacked during military air strikes, occupations, invasions and campaigns.

Finally, the number and sophistication of cyber-attacks is on the rise. Stuxnet is a computer worm discovered in June 2010 that is believed to have been created by the United States and Israel to attack Iran's nuclear facilities. It switched off safety devices, causing centrifuges to spin out of control. The computers of South Korea's nuclear plant operator (KHNP) were also hacked in December 2014. The cyber-attacks involved thousands of phishing emails containing malicious codes, and information was stolen.

The Table 6-3: A summary of nuclear accidents and incidents that have occurred in the world below indicates the nuclear accidents and incidents that have occurred in the world;-

Table 6-3: A summary of nuclear accidents and incidents that have occurred in the world

Date	Location of Accident	Description of accident	Causalities	Cost (USD million)	International Nuclear and Radiological Event Scale (INES) Level
July 26, 1957	Simi Valley, California, United States	Partial core meltdown at Santa Susana Field Laboratory's Sodium Reactor Experiment.	0	32	
January 3, 1961	Idaho Falls, Idaho, United States	Explosion at SL-1 prototype at the National Reactor Testing Station. All 3 operators were killed when a control rod was removed too far.	3	22	4
October 5, 1966	Frenchtown Charter Township, Michigan, United States	Partial core meltdown of the Fermi 1 Reactor at the Enrico Fermi Nuclear Generating Station. No radiation leakage into the environment.	0	132	
December 7, 1975	Greifswald, East Germany	Electrical error causes fire in the main trough that destroys control lines and five main coolant pumps	0	443	3
February 22, 1977	Jaslovské Bohunice, Czechoslovakia	Severe corrosion of reactor and release of radioactivity into the plant area, necessitating total decommission	0	1,700	4
March 28, 1979	Three Mile Island, Pennsylvania, United States	Loss of coolant and partial core meltdown due to operator errors. There is a small release of radioactive gases. See also Three Mile Island accident health effects.	0	2,400	5
September 15, 1984	Athens, Alabama, United States	Safety violations, operator error, and design problems force a six-year outage at Browns Ferry Unit 2.	0	110	
April 26, 1986	Chernobyl, Chernobyl Raion(Now Ivankiv Raion), Kiev Oblast, Ukraininan SSR, Soviet Union	Overheating, steam explosion, fire, and meltdown, necessitating the evacuation of 300,000 people from Chernobyl and dispersing radioactive material across Europe (see Effects of the Chernobyl disaster)	30 direct, 19 not entirely related and 15 minors due to thyroid cancer, as of 2008	6,700	7

Date	Location of Accident	Description of accident	Causalities	Cost (USD million)	International Nuclear and Radiological Event Scale (INES) Level
May 4, 1986	Hamm-Uentrop, West Germany	Experimental THTR-300 reactor releases small amounts of fission products (0.1 GBq Co-60, Cs-137, Pa-233) to surrounding area	0	267	
March 31, 1987	Delta, Pennsylvania, United States	Peach Bottom units 2 and 3 shutdown due to cooling malfunctions and unexplained equipment problems	0	400	
February 16, 2002	Oak Harbor, Ohio, United States	Severe corrosion of control rod forces 24-month outage of Davis-Besse reactor	0	143	3
August 9, 2004	Fukui Prefecture, Japan	Steam explosion at Mihama Nuclear Power Plant kills 4 workers and injures 7 more	4	9	1
July 25, 2006	Forsmark, Sweden	An electrical fault at Forsmark Nuclear Power Plant caused one reactor to be shut down	0	100	2
March 11, 2011	Fukushima, Japan	A tsunami flooded and damaged the plant's 5 active reactors, drowning two workers. Loss of backup electrical power led to overheating, meltdowns, and evacuations. One man died suddenly while carrying equipment during the clean-up. The plant's 6th reactor was inactive at the time.	2+	Estimated 1100 - 1900[31]	7
12 September 2011	Marcoule, France	One person was killed and four injured, one seriously, in a blast at the Marcoule Nuclear Site. The explosion took place in a furnace used to melt metallic waste.	1		

Source: Benjamin K. (2008)

6.4.2.4 Encroachment of the Way Leaves

The increase in Kenya's population has led to a shortage of cheap housing and contributed to overcrowding and mushrooming of informal settlements. Due to inadequate housing, high unemployment rates and the ever-increasing rents, informal settlements have mushroomed to an extent that is not manageable. Most of them are located along wayleaves to transmission lines, water supply networks, roads, etc. regardless of the impeding danger. It is the government's responsibility to ensure the safety and wellbeing of its citizens, by preventing encroachment of the way leaves. A strategic plan should be put in place to tackle this element of safety, starting with mapping and evictions from high risk areas such as the reactor buffer zones and substation and transmission lines' buffer zones, providing safer alternatives as the government works towards sustainable settlement solutions. The government should also invest in monitoring and enforcement of way leaves encroachment through financing and establishment of an authority that specifically addresses infrastructural way leaves.

6.4.2.5 Safety Training and Education

Inadequate knowledge on safe working procedures can be catastrophic. The lack of adequate safety training and education on management of nuclear plants can result in incidences and accidents of the workers and the community.

6.4.2.6 Community Health and Safety

Activities such as construction, installation of transmission lines and, and decommissioning may result in temporary to long-term impacts to other users within the area of operation.

6.4.2.7 Severe Weather Facility Shutdown and Emergency Response Plans

In the event of extreme weather phenomenon such as el-nino, la-nina, hurricanes, heat strokes, sand storms and flash floods high-impacts on the environment and the community might be experienced. The Fukushima nuclear accident in 2011 was mainly attributed to the tsunami. The emergency response plans played a major role in sustainability of Fukushima Daini facility due to the successful implementation of the accident management Plan which was not the case for the Fukushima Daichii facility.

6.4.2.8 Security

Access by unauthorized parties should be avoided by means of gates. Access to the nuclear facilities by unauthorized parties may lead to a significant impact on the environment, community and the workers. The proliferation of nuclear weapons is a factor to consider when implementing security of a nuclear facility.

6.4.3 Capacity Building

The Nuclear Power sector in Kenya is at its infancy and therefore important skills and knowledge to manage the challenges it may present may be lacking especially in developing standards operating procedures and regulations with regards to security, safety and radioactive incident/ accident management. There will be lessons learnt as the skills and knowledge are applied in the development of the first series of the nuclear plants. Some of these lessons may be positive or negative impacts.

6.4.4 Financing Occupational Health and Safety

The financing of occupational safety and health services has largely been from the Government budgetary allocations, which have proven inadequate. With the enactment of the Occupational Safety and Health Act (OSHA), 2007 more responsibilities were added to Directorate of Occupational Safety and Health Services (DOSHS) without additional financial allocation. The responsibilities include research, training, awareness creation, advisory services to stakeholders, development of codes of practice and guidelines, provision of outreach services to the community at large and other OSH promotional activities. The government has however established an Occupational Safety and Health Fund into which occupiers of workplaces will make contributions to enhance OSH awareness activities.

6.4.5 Information and Advisory Services on OSH

There is no reliable system of collecting, compiling and notifying of occupational accidents and diseases hence limited occupational safety and health information to enable necessary intervention. The country very has little comprehensive and synchronized research strategies to provide information and solutions on OSH problems.

6.4.6 Relevant Existing Problems

This section covers existing problems in view of stakeholder perceptions as well as industry practice in relation to the local Environmental Health and Safety management procedures.

6.4.6.1 Duplication of Roles by Local Statutory Institutions

Kibwage *et. al*, 2017 (oil and gas SESA) identified that there has been duplication of duties of agencies in the country with similar objectives of OSH inspections when undertaking routine inspections. NEMA has been playing the role of DOSH due to the latter's inadequate capacity in terms of representation of personnel on ground. However, the performance of NEMA OSHA (2007) requirements has been limited. EMCA Cap 387 requires a coordinated approach with other lead institutions to avoid conflicts of application of policies. Conflict of interest between NEMA and ERC was also noted. Thus, need for harmonization is key emphasis on technical implementation of Energy Standard Practices, some of which bear safety implications.

On the other hand, EIAs, EAs and other interventions notably concentrate on safety and environment, while public health issues are not well captured, particularly when considering receptor points. Ministry of Health advises on good coordination between NEMA, DOSH and themselves for inclusivity. It is therefore important, with eminent entry to the Nuclear Power Programme to properly align the mandates of all line agencies in safety. Due to the stringent international requirement on nuclear safety, an inter-agency committee between, NEMA, NuPEA ERC and DOSHS should be formed to work out on the way forward in coming up with National Nuclear Safety Guidelines.

6.4.6.2 Human resource inadequacy

There is inadequate operation capacity in NEMA's field (county) offices at human resource and infrastructure capacity. Additionally, NEMA doesn't have requisite capacity on Nuclear Power programmes and related activities which could be tied down to the sector being at its entrant level and lack of capacity for the local universities on Nuclear Energy courses.
The same case applies to the DOSHS whose presence at the county level is quite minimal.

6.4.6.3 Disconnect of the Ministry of Health Services at the County Level

Concerns about the devolution of the Health services from the National to the County levels creating disconnect and fragmentation of the way medical services are delivered were raised. Most of the stakeholders were of the idea of medical services being managed by the national government. Despite the presence of the county hospitals, most patients or victims with major injuries from high casualty incidences are rushed to the national and referral hospitals due to inadequate hospital equipment and personnel in the County hospitals.

With the eminent entry to Nuclear Power, there will be need to specialised departments in public hospitals to deal with NPP related health issues with adequate relevant infrastructure. This special department to be cascaded from the national referral hospitals to the county level '5' hospitals.

6.4.6.4 Disaster Risk Reduction and Emergency Response Management Plans

Generally, disaster preparedness and management in the country is quite low. The energy sector has an inherent risk to the community due to high voltage, thermal release, radiation etc. The energy sector needs to develop specific stand-alone emergency response plans on the national level for each sub-sector i.e. oil and gas, nuclear, hydro-electric, geothermal, coal etc. Training and feedback mechanism should be integrated the response systems for adequacy of their implementation, monitoring and improvements.

6.4.6.5 Public Awareness

One of NuPEA's core duties is creation of public awareness of public acceptance and social license to operation for NPP. The public perception is majorly invoked due to safety fears. To date since NuPEA's institutionalization, there exists inadequate public awareness on the safety risks leading and facts about the proposed NPPs. Analysis of cumulative impacts

Cumulative impacts are impacts which result from the incremental impact of a proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities. IFC defines cumulative as those impacts that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones. It is anticipated that cumulative impacts water, energy, construction material, existing infrastructure, housing and social amenities within the candidate sites region and environs might arise due to the needs for the simultaneous development of other interlinking plans. Based on this, the SESA undertook a Cumulative Impacts Analysis (CIA) as described in succeeding sections.

6.5 Cumulative Impacts Analysis (CIA)

Cumulative Impact Analysis is a systematic procedure for identifying and evaluating the significance of effects from multiple activities. CIA was carried out during the Strategic Environmental and Social Assessment as it considers a wider temporal and spatial scope at an early level of the planning process. With reference to Nuclear Power Programme, cumulative impacts can occur from the combined impacts of plans, policies and proposals on specific areas or sensitive receptors. The Nuclear Power Programme is anticipated to generate several

cumulative impacts from the different candidate sites considered in its development. During the CIA, the following elements that define the cause-effect relationship of the impacts according to Cooper (2004) were used;

- Identification of the impact sources i.e. multiple activities that could lead to potential impacts or environmental changes
- Consideration of the pathways of impacts between sources and receptors and the linkages between these impacts
- Analysis of the characteristics of these impacts i.e. whether they are additive, synergistic or antagonistic

The CIA process took place in several steps, some of which were done concurrently with the initial steps of the SESA process. The CIA for the proposed master plan was undertaken in the process summarized as follows:

- Scoping in consultation with the relevant key stake holders and agencies
- Establishing of the baseline characteristics of the proposed master plan
- Assessing the impacts of the master plan
- Proposing mitigation measures for the potential significant impacts
- Development of a monitoring plan – Chapter 10 of this SESA
- Incorporating findings

6.5.1 Linkages

These are the plans, programmes, policies or programmes that are interlinked to the NPP development whose impacts added on to the NPP impacts could cause either positive or negative incremental effect to the environment or the society.

Some of these the plans, programmes, policies or programmes are:

- Ongoing plans and programmes (such as upstream petroleum activities, construction of ports & jetties)
- Power Transmission Lines and Substations
- Access roads construction
- Communication infrastructure
- Workers/ Staff Housing

6.5.2 Cumulative Positive Impacts

6.5.2.1 Improved grid connection

The implementation of the NPP and subsequent installation of High Voltage transmission lines and substations will ensure an improved national transmission grid for a cheaper and reliable electricity both locally and regionally through the High Voltage Interconnector Lines such the Eastern Electricity Highway Project (a double circuit bidirectional 500HVDC line that connects Kenya and Ethiopia); The Kenya Tanzania 400 kV Transmission Line and the Lessos- Tororo 400kV Transmission Lines are under implementation by KETRACO.

6.5.2.2 Improved communication network coverage

Implementation of the NPP will require the construction and installation of communication networks for coordination and security reasons. This will therefore connect the candidate areas to communication channels improving information availability hence boosting business networks in the area through provision of communication essentials such as the reliable internet network.

6.5.2.3 Increased job opportunities in the area

As much as NPP implementation is highly technical requiring specific technology, in its undertaking the requirement of non-skilled labour will be necessary both in the construction and in operational phase for both NPP and other support and associated projects that will come up. Additionally, the installation of other key utilities such as transmission lines, housing etc. would be importance to the locals in provision of jobs and business opportunities for supply of construction material.

Moreover, locals within the candidate site and even nationally with specialized skill and training are likely to benefit from specialized job opportunities.

6.5.2.4 Improved literacy level within the neighbouring community

As listed above, the NPP linkage with other projects in the area will lead to skill and experience gaining for locals who are likely to be employed in such projects.

Additionally, as the communities may negotiate with proponents of such projects, Corporate Social Responsibility (CSR) activities can be launched for social cushioning of the communities in the candidate sites. Some of the CSR activities can include student sponsorship for specialized training, construction of schools and vocational centres etc.

6.5.2.5 Contribution towards reduction of environmental pollution

The dominant energy source in the county is fuel-wood. The projects will provide alternative energy source and thus reduce reliance on fuel-wood thereby contributing towards among others, the national goal of meeting the minimum forest cover.

6.5.3 Cumulative Negative impacts

6.5.3.1 Increased demand for housing / Population influx

With the implementation of multiple projects within the candidate sites, there is expected to be a population influx within such areas for job search and business opportunities which lead to a further train on natural resources such as water and energy as well social resources such as housing, hospitals, schools etc.

Such influx population will be pre-requisite for insecurity in the area, failure of social governance, moral decadence and acculturation of the host community.

6.5.3.2 Involuntary resettlement

The NPP and associated projects such as transmission lines, substations and access roads will necessitate the provision of land for the construction of such utilities. This will necessitate either involuntary resettlement for roads, substations, nuclear plants, nuclear waste storage and disposal sites or limit of land owner-use of the rights to land in case of transmission lines where wayleave is necessary.

6.5.3.3 Increased demand for water use

Construction of projects listed above cumulatively need water as a resource in their undertaking. The NPP would need water in installation, civil works as well all the other associated projects. During NPP operation water will be essential for purposes of cooling. Coupled with the population influx in the candidate sites, the amount of water abstracted will be high. Water quality is likely to be compromised from these operations through effluents, the risk of thermal and radioactive pollution.

6.5.3.4 Loss of biodiversity

The need for Right of Way for roads and wayleaves for transmission lines would lead to clearance of vegetation to pave way for the construction of such projects. Considering the fact that, the transmission lines' capacity would be high, the wayleave needed therefore in accordance to the international safety standards would be high therefore a huge impact on the existing vegetation within the candidate sites.

The proximity of candidate sites to drainage basins rich in aquatic species, risks such aquatic population to the pressures of such developments which can result to habitat modification; noise and pressure effects; Impingement and entrainment; heat discharges and transmission line crossings (U.S. Nuclear Regulatory Commission , 2014).

6.5.3.5 Increased air pollution

Particulate matter pollution is likely to occur during the site clearance, excavation and spreading of the topsoil, building of dykes and canals, loading and transportation of the construction waste. There is a possibility of PM10 suspended and settle-able particles affecting the site workers and even surrounding neighbours' health.

Exhaust emissions are likely to be generated during the construction period by the various construction machinery and equipment. Motor vehicles used to mobilise the work force and materials for construction would cause a potentially significant air quality impact by emitting pollutants through gaseous exhaust emissions.

6.5.3.6 Increased noise pollution and vibration

The construction works will most likely be a noisy operation for all projects due to the moving machines (mixers, excavators, tippers, communicating workers) and incoming vehicles to deliver construction materials and workers to site. Vibrations will be caused by possible rock blasting in construction of transmission lines. To some degree, site workers and neighbours are likely to be affected since noise beyond some level is itself a nuisance and thus should be controlled within acceptable limits.

6.5.3.7 Waste Management

a. Solid Waste

The industrial, commercial, educational and residential zones will lead to generation of more solid waste. The solid waste if not handled properly could lead to unpleasant smells and spread of diseases by some rodents.

b. Radioactive Waste

- **On the Environment**

When soil is contaminated by radioactive substances, the harmful substances are transferred into the plants growing on it. It leads to genetic mutation and affects the plant's normal functioning. Some plants may die after such exposure, while others may develop weak seeds. Eating any part of the contaminated plant, primarily fruits, poses serious health risks. Since plants are the base of all food chains, their contamination can lead to radioactive deposition all along the food web. Similarly, when radioactive waste is washed up in a water source, it can affect the entire aquatic food web.

Both terrestrial and aquatic radioactive contamination can culminate in human consumption. Since humans are apex predators, the accumulation of radioactive materials on the last rung of the food chain would be maximum

.

- **On Human Beings**

The impact of radioactive pollution on human beings can vary from mild to fatal; the magnitude of the adverse effects largely depends on the level and duration of exposure to radioactivity. Low levels of localized exposure may only have a superficial effect and cause mild skin irritation. Effects of long, but low-intensity exposures include nausea, vomiting, diarrhoea, loss of hair, bruises due to subcutaneous bleeding etc.
Long-term exposure or exposure to high amounts of radiation can have far more serious health effects. Radioactive rays can cause irreparable damage to DNA molecules and can lead to a life-threatening condition. Prolonged exposure leads to a large number of molecules in the body being ionized into free radicals. Free radicals promote the growth of cancerous cells, i.e. tumours, in the body. People with heavy radiation exposure are at a very high risk for cancers.

The rapidly growing/dividing cells, like those of the skin, bone marrow, intestines, and gonads are more sensitive towards radioactive emissions. On the other hand, cells that do not undergo rapid cell division, such as bone cells and nervous cells, aren't damaged so easily.

Skin cancer, lung cancer and thyroid cancer are some of the common types of cancers caused by radiation. The effects of genetic mutation are passed on to the future generations as well. In other words, if the parents are exposed to nuclear radiation, their child could have severe congenital birth defects, both physical and mental. This is tragically illustrated in the case of Hiroshima and Nagasaki, where the aftereffects of nuclear radiation were carried on for generations, and thousands of children were born with physical abnormalities and mental retardation. The radiation also brought about a spike in cancer; the region still (after more than 65 years) has a much higher rate of cancer and congenital abnormalities than the rest of Japan.

6.6 Climate Change Vulnerability, Adaptation and Mitigation

According to the IAEA, (2018), Climate change is one of the most important issues facing the world today. Nuclear power can make an important contribution to reducing greenhouse gas emissions while delivering energy in the increasingly large quantities needed for global economic development. Nuclear power plants produce virtually no greenhouse gas emissions or air pollutants during their operation and only very low emissions over their full life cycle.

The advantages of nuclear power in terms of climate change are an important reason why many countries intend to introduce nuclear power or to expand existing programmes in the coming decades. All countries have the right to use nuclear technology for peaceful purposes, as well as the responsibility to do so safely and securely.

As a large-scale energy source, nuclear power has a significant potential to contribute to GHG emissions reduction. Nuclear power has avoided a significant amount of CO_2 emissions in recent decades. In the absence of nuclear energy, and assuming, that fossil fuel technologies had produced the corresponding amount of electricity according to their historical shares in the electricity mix, CO_2 emissions would have been considerably higher. Over the period 1970–2015, nuclear power avoided around 68 gigatonnes of CO_2 in total, close to the entire actual emissions from the power sector over 2010–2015.

The contribution of nuclear energy to GHG mitigation over the next decades will depend on many factors: the performance of the nuclear industry itself, including technological innovations, economic competitiveness and safety records; developments in the energy sector in general, such as new technologies, their economic performance and resource availability in different countries; and the broader economic and political agenda affecting national decisions about the use of nuclear power. Political decisions and the role of governments
are particularly important.

Although it has a significant potential to contribute to climate change mitigation, nuclear energy also needs to cope with a number of challenges, including the debate around radiation exposure, radioactive waste, off-site effects of nuclear accidents and its high capital costs.

Radiation exposure to the public from the normal operation of nuclear power plants and the nuclear fuel cycle infrastructure is negligible compared with naturally occurring background radiation. Radiation exposure due to human activities — which, besides nuclear power generation, also include the production and use of radioisotopes for medical and industrial use, is subject to strict regulation and control aimed at keeping the radiation exposures within prescribed limits for workers and members of the public. While the devastating earthquake and tsunami in 2011 in Japan caused 20,000 casualties, none were related to the release of radioactive material in the accident at the Fukushima Daiichi nuclear power plant. The levels of radiation exposure from the accident were similar to the global average background levels of radiation and no radiation related health effects are expected among exposed members of the public and their descendants.

7 CHAPTER EIGHT: ANALYSIS OF ALTERNATIVE OPTIONS

7.1 Introduction

In this chapter, a description of the different alternatives to Nuclear Power Program must be analyzed and described. This chapter must clearly show the advantages and disadvantages of the different alternatives highlighted.

7.2 Alternative Energy Sources

Although the use of electricity is' relatively benign, its generation is one of the world's environmentally damaging activities, while the energy sector contributes 49% of greenhouse gases, electricity generation alone produces more than 25% of energy related carbon dioxide emissions (Rashad, 1998).

(Rashad, 1998) still indicated that emissions to the environment have been the major focus of energy impact studies. Other significant impacts such as land disturbance and population displacement together with their economic and social implications being less emphasized. Major impacts such as depletion of natural resources and large fuel and transport requirements that influence a wide range of areas including occupational and public safety as well as national transport systems being highly ignored.

(Giambattista Guidi, 2010) acknoweledges the technological advancements in the nuclear energy sector that have made the sector even more safer compared to all other energy production systems upon an Life Cycle Assessment for all the energy production systems agains the Nuclear Energy system. Nuclear power is an efficient means of reconciling the global imperative of human need and environmental preservation. Further, (Giambattista Guidi, 2010) indicate that studies undertaken since 2000 are skewed towards the economic advantage of nuclear electricty generation with a cost of generation lower compared to fossil-fuelled power plants or renewable sources. Moreover nuclear electricity cost, unlike fossil based electricity cost, already internalizes all end of life costs, such as decommissioning and radioactive waste disposal ones.

Another vital edge of nuclear energy production as detailed by Giambattista Guidi, 2010 is its inherent property of low footrpint to the ecological set-ups. Among the various fossil fuels, coal produces significantly more carbon dioxide per unit of energy produced than oil or gas, accounting for 40% of global CO_2 emissions, although it only has 25% share of total primary energy supply (NEA, 2008). Nuclear Power like hydropower produces almost no CO_2 except for the emissions during construction of the nuclear power plant. On a life cycle basis, extremely low levels of carbon dioxide emissions are produced indirectly from fossil fuel sources used in processes such as construction and transport. Particulate and other gaseous emissions from fossil-fuelled power plants are known to have significant deleterious health effects. Life cycle analyses of electricity production chains show that nuclear power (including the effect of radioactive emissions) is one of the most effective power production technologies for avoiding emissions-related health effects (Giambattista Guidi, 2010).

7.2.1 Nuclear Power

Operational technologies of nuclear power are based on the fission of heavy atoms in which only heat is generated. There are various commercial technologies such as pressurized, boiling and water-cooled graphite moderated light water reactors heavy water reactors; gas-cooled reactors. Due to technical and economic reasons, they operate at constant full load and located at far

distances from urban area and preferably also from industrial mega-complexes due to safety regulations.

7.2.1.1 Spent Nuclear Fuel (SNF) Management

(Hussien, 2014)The management and disposal of Spent Nuclear Fuel is a very important issue in the current and future considerations of expansion of nuclear power and its environmental footprint.

For the 'open' and 'once-through' fuel cycle SNF is waste, which needs to be stored for several decades to reduce radioactivity and radioactive decay heat, and eventually needs to be disposed of in a geological repository. However, only 3% of the SNF can be considered 'real' waste, while uranium and plutonium are extracted and recycled a 'closed' fuel cycle. The 'real' HLW is separated out for further treatment followed by interim storage, pending final disposal in a geological repository.

7.2.1.2 Radiological impact on public and environment

A typical LCA for an NPP is shown in below where there are a number of stages in the nuclear fuel cycle that produce radioactive waste. Over 200 radionuclides are produced during the operation of a typical reactor (Paschoa, 2004); most of the radionuclides are relatively short-lived and decay to low levels within a few decades. A number of radionuclides are emitted from normal operation of NPP.

The annual discharge of gaseous ^{14}C to the atmosphere from pressured water reactors in Germany was 280 ± 20 GBq/GWe in 1999, on average 30% is thought to have been emitted in the form of CO_2 the rest in organic form (CH_4 in particular). In France, ^{14}C discharges were estimated to be 140 GBq/y per unit of 900MWe and 220 GBq/y per unit of 1300MWe (Roussel et al., 2006).

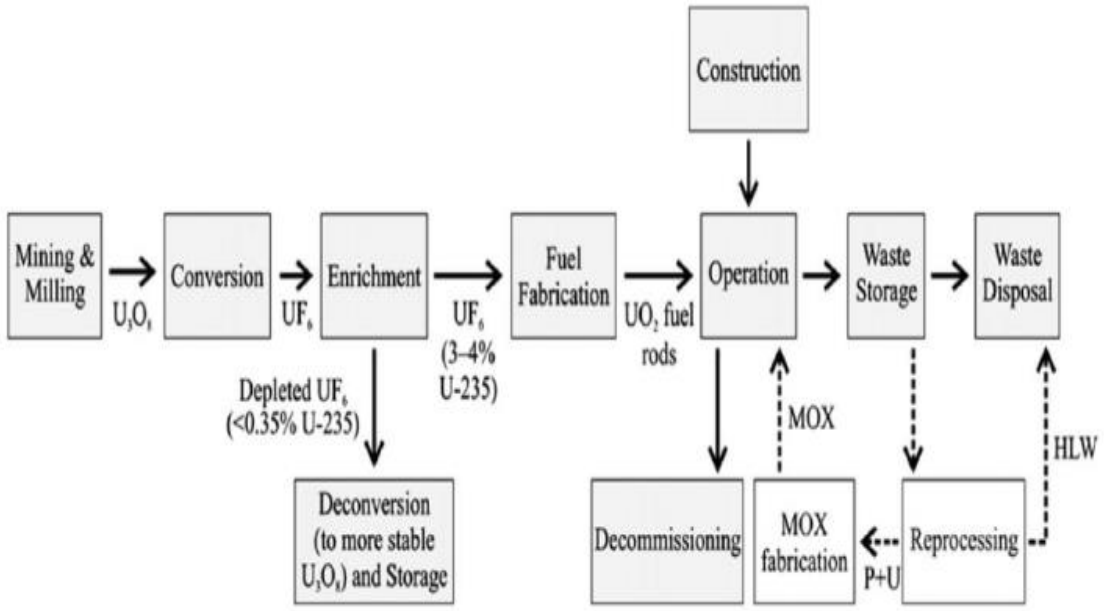

Figure 7-1: The life cycle of nuclear power (HLW: high-level waste; MOX: mixed oxide fuel) Source: (IAEA, 2013)

The radioactive emissions do not only cause radioactive environmental problems from operating nuclear power plants but also other environmental problems (water eco-toxicity, global warming, Ozone depletion, Acidification, Eutrophication, photochemical smog, land use and quality) may arise. (Zwaan, 2013) presents an updated overview of recent literature on the role of nuclear power in mitigating greenhouse gas (GHG) and particulate matter (PM) emissions from electricity generation. On a life cycle basis, nuclear power emits approximately 10 g CO_2 equiv/kWh within an uncertainty range of 5-17 g CO_2 equiv/kWh.

7.2.1.3 Advantages of NPP

According to Bruno Comby Nuclear power is clean, safe, reliable, compact, competitive and practically inexhaustible (http://ecolo.org/documents/documents_in_english/BENEFITS-of-NUCLEAR.pdf).

- **Clean:** Nuclear energy produces almost no carbon dioxide, and no sulfur dioxide or nitrogen oxides whatsoever. These gases are produced in vast quantities when fossil fuels are burned.
- **Nuclear waste**: One gram of uranium yields about as much energy as a ton of coal or oil - it is the famous “factor of a million”. Nuclear waste is correspondingly about a million times smaller than fossil fuel waste, and it is totally confined. In the USA and Sweden, spent fuel is simply stored away. Elsewhere, spent fuel is reprocessed to separate out the 3% of radioactive fission products and heavy elements to be vitrified (cast in glass) for safe and permanent storage. The remaining 97% plutonium and uranium is recovered and recycled into new fuel elements to produce more energy. Nuclear waste is to be deposited in deep geological storage sites; it does not enter the biosphere. Its impact on the ecosystems is minimal. Nuclear waste decays over time while stable chemical waste, such as arsenic or mercury, last forever. Most fossil fuel waste is in the form of gas that goes up the smokestack causing global warming, acid rain, smog and other atmospheric pollution.
- **Safe:** Nuclear power is safe, as proven by the record of half a century of commercial operation, with the accumulated experience of more than 12,000 reactor-years. There have been only two serious accidents in the commercial exploitation of nuclear power: Three Mile Island (TMI) in 1979 (in Pennsylvania, USA) and Chernobyl in 1986 (in the Soviet Union, now in Ukraine). Fewer fatalities have occurred in the civilian nuclear power industry in half a century (Chernobyl included) compared to those that occurred in any year in the fossil fuel industries.
- **Reliable:** Nuclear reactors provide base-load power and are available over 90% of the time; intervals between refuelling have been extended and down time for refuelling has been reduced. In the USA, these improvements over the years led to addition of one reactor a year to the existing fleet. Most reactors are designed for a life of 40 years; many are reaching that age in good condition and extensions of 20 years have usually been granted.
- **Competitive:** The cost of nuclear power is competitive and stable. The cost is a small part of the price of a nuclear kiloWatt-hour, while fossil fuel, especially oil and gas, is market driven.
- **Inexhaustible**: Uranium is found everywhere in the crust of the Earth. It is more abundant than tin, for example. Major deposits are found in Canada and Australia. It is estimated that increasing the market price by a factor ten would result in 100 times more uranium coming to market. Recovery from sea water where 4 billion tons are dissolved forms part of the source.
- **Compact:** A nuclear power station is very compact, occupying typically the area of a football stadium and its surrounding parking lots. Solar cells, wind turbine farms and growing biomass, all require large areas of land.
- **Radiation:** Fear of the unknown is the merchandise of anti-nuclear “greens”. They preach fear of radioactive waste, accidents, and weapons proliferation. Radiation is a mystery to most people, and while it’s present everywhere in the environment. Moderate amount of radiation is natural and beneficial to life. The human body itself is naturally radioactive. Our bodies

contain about 8000 becquerels (8000 atoms disintegrating every second), about half of which is potassium-40, a chemical element essential for health, as well as carbon-14.

- **Old Fashioned Attitudes:** Ecological organizations such as Greenpeace have consistently had an anti-nuclear bias which is more ideological than factual. An increasing number of environmentalists are now changing their minds about nuclear energy because there are very good, solid, scientific and, above all, environmental reasons to be in favor of nuclear energy.

7.2.2 Fossil Fuels

The three fossil fuels crude oil, coal and natural gas fill about 80% of the global energy supply as in**Figure 7-2** below. Fossil fuels are relatively concentrated pure energy sources, technically easy to exploit and at least until today
still provide cheap energy.

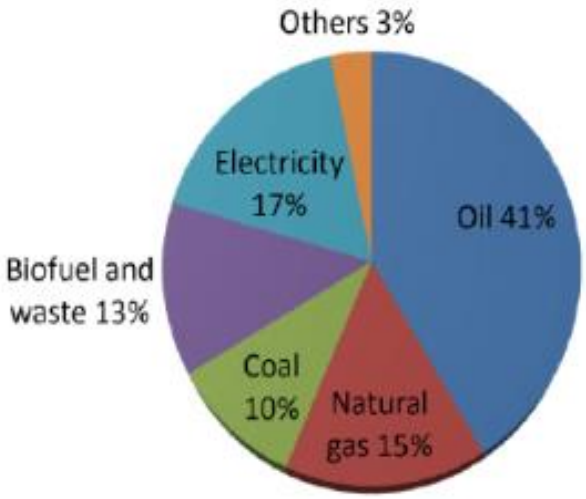

Figure 7-2: Fuel shares of global energy consumption in 2009
Source: (EIA, 2011)

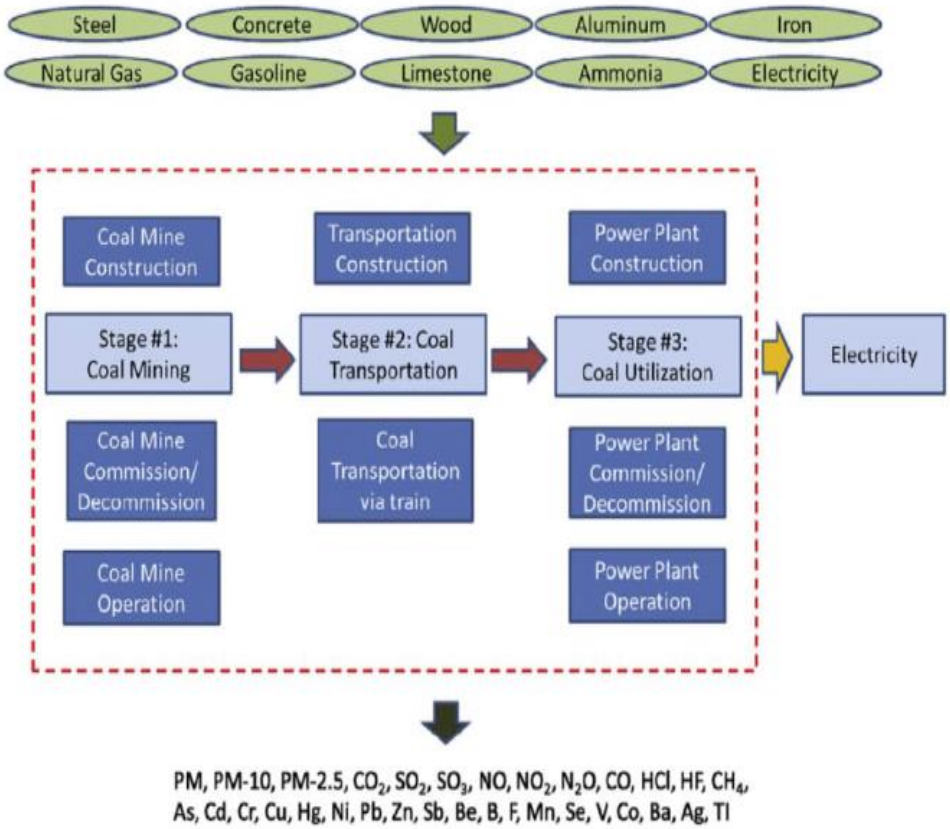

Figure 7-3: Coal Life Cycle Analysis
Source: (Hussien, 2014)

All stages of the coal fuel-cycle including mining, transportation, combustion and disposal of the bottom ash and fly ash cause exposure to the natural radiation as shown in the figure above. These radioactive elements in coal include potassium (^{40}K) and the decay series headed by uranium, thorium, as well as radium and radon as trace elements. The levels of chemical and radiological toxic trace elements in coal are receiving greater attention in the assessment of the environmental impact of electricity generation from Coal-Fired Power Plants (CFPPs) (Nakaoka, 1984 and USGS, 2001). Combustion process converts coal into useful heat energy, but it is also a part of the process that produce greatest environmental and health concerns. Combustion of coal at thermal power plants emits mainly carbon dioxide (CO2), sulphur oxides (SOx), nitrogen oxides (NOx), CFCs, other trace gases and air borne inorganic particulates, such as fly ash and suspended particulate matter (SPM). CO2, NOx and CFCs are greenhouse gases (GHGs). Coal combustion eliminates organic components causing an increase in ash radioactivity compared to coal radioactivity. During combustion heavier portion of ash, together with incompletely burned organic matter fall to the bottom of the furnace known as bottom ash. Fly ash, the lighter portion, is carried through the boiler. Most of the fly ash is collected with electrostatic filters while rest is released to the atmosphere.

In putting CFPPs and NPPs side to side (Rashad, 1998) indicates that a 1000 MW(e) coal plant, without abatement technology, produces annually an average of some 44 000 tonnes of sulphur oxides and 22000 tonnes of nitrous oxides that are dispersed into the atmosphere coupled with there are 320000 tonnes of ash containing 400 tonnes of heavy metals arsenic, cadmium, cobalt, lead, mercury, nickel and vanadium quantities which ignore energy-chain activities, such as mining and transportation

7.2.2.1 Oil as source of energy

Crude oil (liquid petroleum) forms underground in rock such as shale which is rich in organic materials. After the oil forms, it migrates upward into porous reservoir rock such as sandstone or limestone, where it can become trapped by an overlying impermeable cap rock. Greenhouse gases, primarily in the form of carbon dioxide and methane, are emitted during a variety of stages in oil sands production as shown in the LCA **Figure 7-4** below:

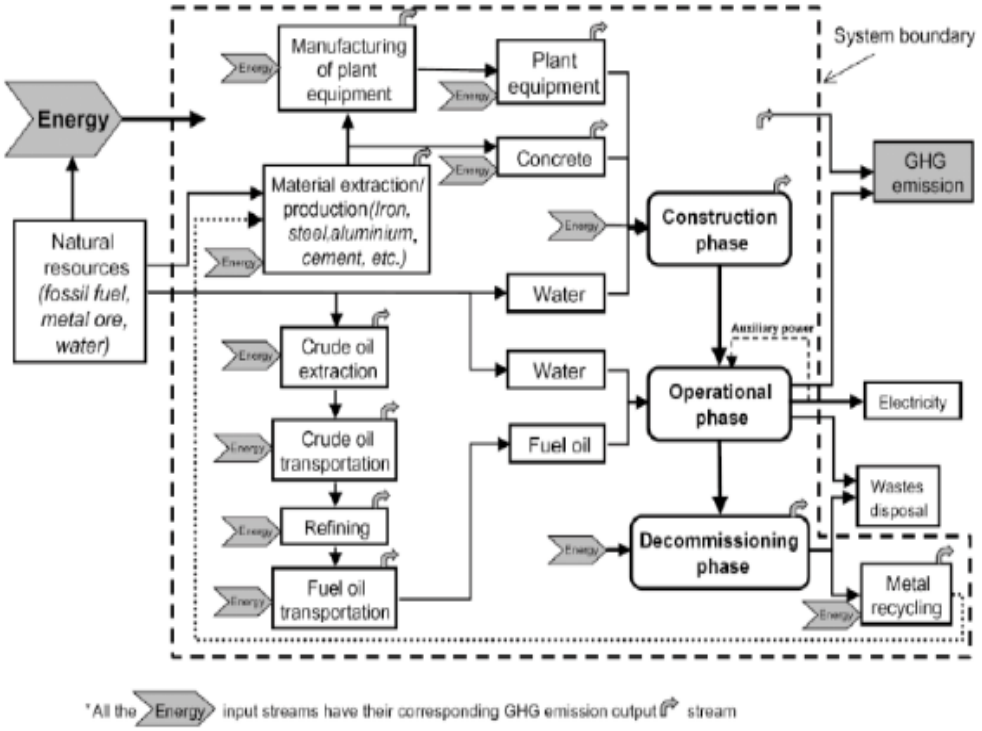

Figure 7-4: LCA boundary of oil fired power plant
Source: (Kannan, 2004)

7.2.2.2 Natural Gas as an Energy Source

Natural gas is generally considered a non-renewable fossil fuel and is the cleanest burning fossil fuel but emissions must be further reduced to reach GHG reduction targets. LCA shows emissions associated with natural gas are a fraction of the associated coal emissions but LCA also indicates what stage has the most potential for improvement throughout the life cycle of natural gas. (Hussien, 2014).

An assessment of the environmental impacts of natural gas combined cycle (NGCC) electricity generation with carbon dioxide capture and storage (CCS) by (Singh et al., 2011). The result showed an increase in all environmental impacts except the global warming potential (GWP). The impacts are unequally distributed over various processes, e.g., natural gas exploration, transport, combustion at the power plant, CO_2 capture, infrastructure, solvent production, as well as locations, e.g., offshore natural gas production facility, chemical manufacturing sites, power plant facility, dispersed transportation, iron and steel industry, mining sites, etc. Direct emissions at the power plant facility consist of various substances as NO_X, SO_X, NH_3, MEA vapours, acetaldehyde, formaldehyde and hazardous reclaimed wastes. The capture process while capturing CO_2 also reduces NOx, SO_2 and particulate emission, however their net removal efficiency per kWh electricity generation is lower than the designed performance parameter, due to increased

combustion of natural gas to meet the energy requirement of the capture process. The energy penalty also results in increased emission of CH_4, CO and other pollutants which are not captured by the process.

7.2.3 Hydropower

Hydropower plants can be divided into two groups, according to their operating regime: run-of-river and peak hydropower plants (Hussien, 2014). Environmental impacts of run-of-river type hydroelectric power plants have many dimensions associated with both construction and operational phases. The issues that are expected to occur during the construction phase include dust emissions, air pollution, noise, erosion, landslide, and excavation debris. Dust and landslide are the major problems of the construction phase that cause health and environmental degradation problems. Other issues include water released back to the river, efficiency of fish passages, sediment passages, access roads and energy transmission lines are the main considerations of the operational phase. Aquatic life may be adversely impacted in the diversion reach if sufficient amount of water is not kept in the river for sustaining a healthy aquatic habitat.

Social Issues related to HEP, include displacement of people, community safety and health and risk of dam failure.

7.2.4 Geothermal Power

Geothermal energy is heat stored in the Earth's crust within the rocks and fluids. It is this heat, which provides the mode for electricity generation or for direct use. The temperature within the Earth increases with depth, and consequently, the heat resources can be used through drilling wells and piping steam or hot water to the surface (Taleb, 2009). There are two fundamental approaches in utilizing geothermal energy:

- Hydro geothermal: Hot water reservoirs tapped underground. This water can be then used for heating and where temperature is high enough, used for electricity generation
- Hot dry rock: Water pumped into a fundamental hot plutonic rock under high pressure. The water heats up

underground and return via a second borehole. This allows the heated water to be used for electricity and water (Hussien, 2014).

The potential environmental impacts deriving from geothermal energy production have been detailed in the literature (Kristmannsdóttir and Ármannsson, 2003). These can be summarized as follows:

- Surface disturbance: clearing of land, changes in landscape and the introduction of manmade structures where none existed before
- Physical effects on fluid withdrawal: fluid withdrawal include subsidence, lowering of the groundwater table and induced seismicity as earth layers consolidate due to the removal of fluids from matrix pore spaces or when increased pressure due to injection causes the relief of accumulated geological stresses
- Noise: caused by steam and non-condensable gas emissions to the atmosphere and the discharge of brine to surface or subsurface water bodies
- Thermal effects: elevated temperatures of rivers, lakes and groundwater due to thermal fluid
- Chemical pollution: discharges and changes in cloud formation and local weather due to steam emissions
- Biological effects
- Protection of natural features

7.2.5 Wind and Solar Energy

Wind and Solar Energy have a very minimal emission coefficient as close to that of Nuclear Power.

7.3 Alternative Candidate Site Analysis

In analysis of all the NPP candidate sites, a number of factors were put to consideration as criteria to select the alternative sites as detailed in section 3.7 on Environmental and social baseline situation and site suitability analysis above. The tool analysed the parameters that are critical for the development of nuclear power plants. These include flooding index, availability of water and its quality, present biodiversity, the weather conditions, geology of an area that is, traceability of fault lines and earthquakes, infrastructure development and the socio-economics. Three regions met the minimum requirements these were: -Lake Victoria, Lake Turkana, and the Coastal region.

Considering the ranking of individual counties for the three regions and upon weighting of all factors, the Coast region is the best option preferred for NPP installation due to its proximity to the Indian Ocean. Further, as per the ranking of counties within the Indian Ocean belt, Tana River County therefore becomes the most preferred county for the NPP as shown in the Table 7-1: Overall ranking of the water candidate sites.

Table 7-1: Overall ranking of the water candidate sites

Candidate site	County	Weighting	County Ranking	Overall score	Suitability option
Lake Victoria Basin	Siaya	0.84	1	0.74	**2**
	Kisumu	0.66	3		
	Homa Bay	0.81	2		
	Migori	0.63	4		
Lake Turkana Basin	Turkana	0.71	2	0.74	**2**
	Marsabit	0.79	1		
	Samburu	0.71	2		
Coastal Region	Tana River	0.88	1	0.76	**1**
	Lamu	0.75	2		
	Kilifi	0.70	3		
	Mombasa	0.70	3		
	Kwale	0.75	2		

Source: (SGS, 2019)

Lake Victoria and Lake Turkana regions tie, and this is mainly due to the high flooding index and the socio-economics of the regions. Both regions have seasons of flooding and the people are dependent mainly on the water bodies for their livelihood making them unsuitable for NPP installation unlike the Coastal region that has various alternative sources of livelihood and does not face the challenges of flooding. The table below ranks the counties according to their suitability.

Table 7-2: County Ranking According to suitability

County	Water Basin	Weighting	County Ranking
Tana River	Coastal Region	0.88	1
Siaya	Lake Victoria	0.84	2
Homa Bay	Lake Victoria	0.81	3
Marsabit	Lake Turkana	0.79	4
Lamu	Coastal Region	0.75	5
Kwale	Coastal Region	0.75	5
Turkana	Lake Turkana	0.71	7
Samburu	Lake Turkana	0.71	7
Kilifi	Coastal Region	0.70	9
Mombasa	Coastal Region	0.70	9
Kisumu	Lake Victoria	0.66	11
Migori	Lake Victoria	0.63	12

Source: (SGS, 2019)

In summary, Tana River County is the most suitable for NPP installation to the tune of 88% while Migori County being the least preferred at 63%.

7.4 Alternative NPP Development Technologies

7.4.1 Types of nuclear reactors

The types of reactors are given below. It is not our intention to describe every possible nuclear reactor design in detail, but to give a brief description of the reactor types with focus on the main reactor designs operational today.

7.4.1.1 Light water reactors

Light water reactors are reactors that use regular water for cooling and as a moderator. Most nuclear power plant reactors in the world are light water reactors. There are two types of LWR designs: the pressurized water reactor (PWR) and the boiling water reactor (BWR).

Pressurized water reactor (PWR): The pressurized water reactor operates under a high pressure; this act to increase the boiling point of the coolant, enabling more efficient heat transfer. The reactor plant has two separate circulation systems. In the primary circuit, fuel heats the water up to 300-330 °C, but the high pressure (120–160 bar) prevents the formation of steam. The high-pressure water coming from the reactor is led to steam generators (heat exchangers) where the water in a separate secondary circuit kept at lower pressure (45-78 bar) is vaporized. The steam drives the turbine to produce electricity and is then condensed and returned to the heat exchangers in contact with the primary circuit. The steam in the reactor system and turbine plant is kept separated. As a result, water in the secondary circuit is not radioactive. The primary circuit of the PWR reactor is completely in the containment building.

A variation of the PWR in Russia is known as VVER which stands for water-cooled water-moderated energy reactor. These reactors differ from other PWRs in some design features, notably the VVER fuel assembly has a hexagonal shape instead of the squared geometry of a PWR fuel assembly.

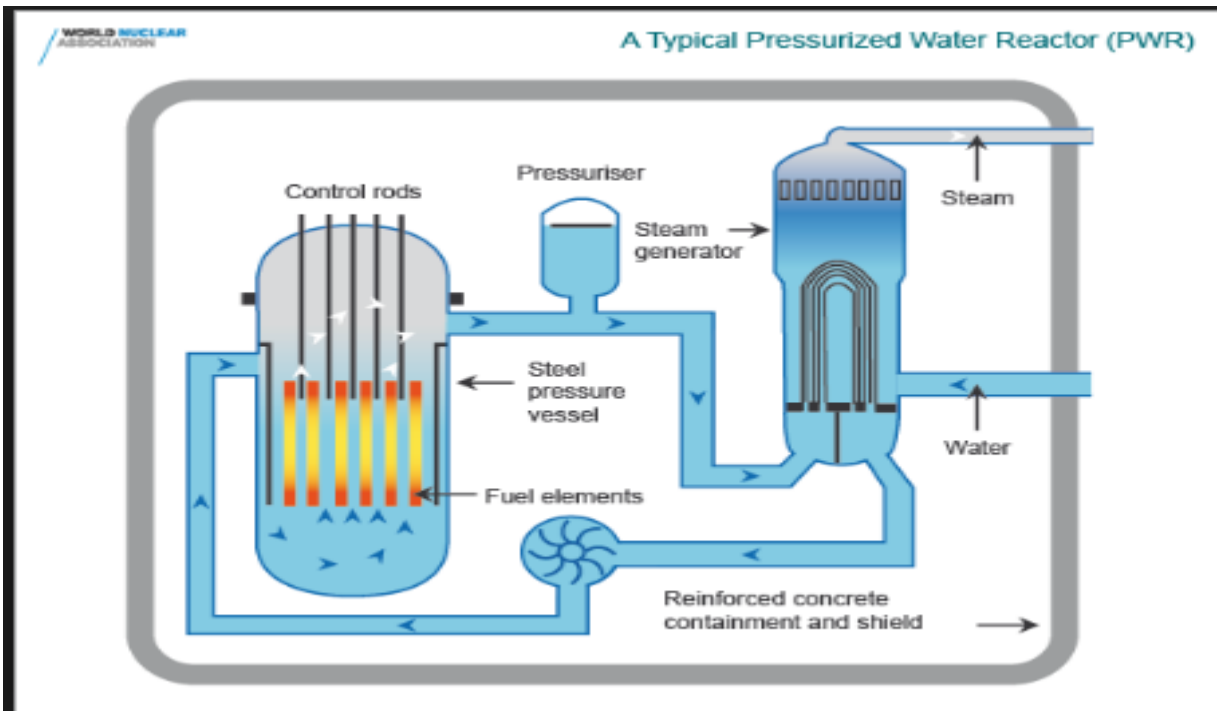

Figure 7-5: Operating principle of a pressurized power plant reactor
Source: (World Nuclear Association. July 2008).

Shaw 2017, Zarubin 2015 and Crerend 2015 give the follwing advantages and disdavnatages for the Pressurized water reactors

Advantages

- They are easy to operate because less power is being produced as the heat increases
- The core of the reactor contains less fissile material, decreasing the chances of additional fission events to occur, making the reactor safer and more controllable. In other words, it contains "less fissile material than is required for them to go prompt critical".
- The most advantageous element of the PWR is the turbine cycle. Since the primary and secondary loops are separate, water can never be contaminated by radioactive material in the main system loop. Conclusively, the water from the primary and secondary loops will never touch or mix, so there is no chance for contamination.

Disadvantages

- The reactor requires very strong piping and a heavy pressure vessel in order to ensure that the highly pressurized water remains at a liquid state when sustaining high temperatures, making the construction of the PWR costly.
- Reactors need to be refuelled after about 18 months, and cannot be refuelled while the reactor is running. Since the refuelling process takes a few weeks, the reactors must go offline for this time.

- Although no water contamination in the main cycle exists, boric acid, which is corrosive to carbon steel, can get melted into the coolant causing radioactive products to circulate throughout the loop. These radioactive yields are destructive to the reactor (i.e. potential for radiation exposure) ultimately limiting the reactor's operating life

Boiling water reactor (BWR): The boiling water reactor (**Figure 7-6**) has a simpler steam generation process than the pressurized water reactor. Water is circulated at a pressure of approximately 70 bar through the core acting as both moderator and coolant, inside the pressure vessel. The fissions in the fuel heat the water to about 300 °C. As a result, 12-15% of the water is converted into steam in the reactor and is introduced in the turbine. The remaining steam then passes through a condenser, where it releases its remaining heat into water pumped from the water system and condenses into water. This water is returned to the pressure vessel to complete the circuit. The BWR fuel is in the form of fuel rods with radius slightly bigger than for PWR fuel assemblies, but BWR fuel assemblies have fewer pins (e.g. 8x8 or 10x10 lattice) than PWR assemblies (e.g. 15x15 or 17x17 lattice). The power density (energy per unit volume of core) for BWR reactors is about half of PWR reactors because of the lower operating temperatures and pressures.

Because the primary water in the core of a reactor contains traces of radionuclides, direct access to the turbine during operations is not allowed. However, most of the radioactivity in the water is very short-lived, so the turbine hall can be accessed soon after the reactor is shut down.

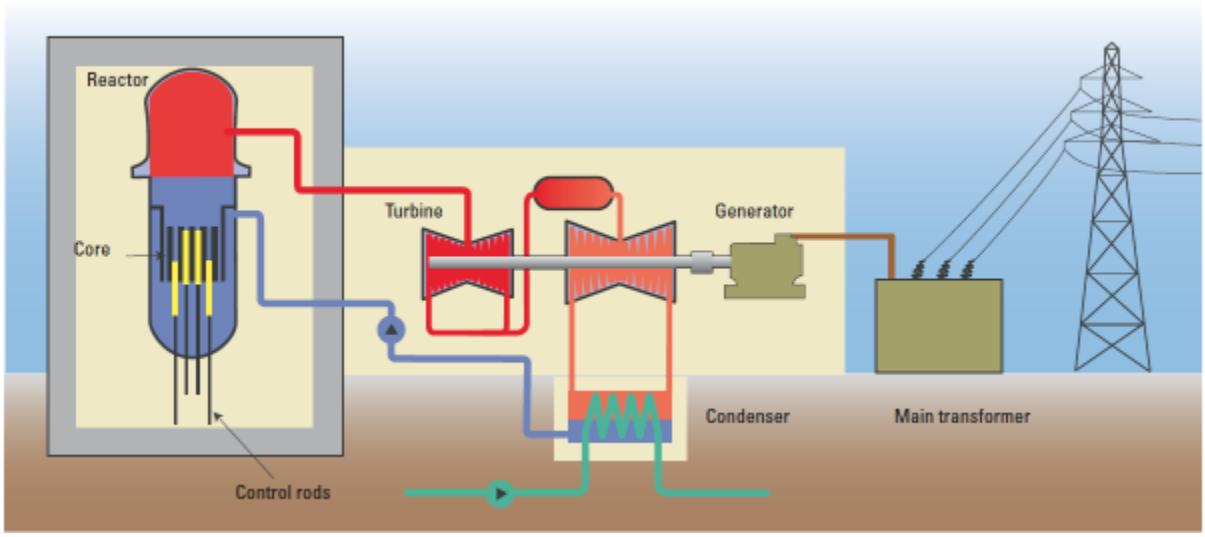

Figure 7-6: Operating principle of a boiling water reactor
Source: (World Nuclear Association. July 2008)

Advantages

- The reactor vessel and associated components operate at a substantially lower pressure (about 75 times atmospheric pressure) compared to a PWR (about 158 times atmospheric pressure).
- Pressure vessel is subject to significantly less irradiation compared to a PWR, and so does not become as brittle with age.
- Operates at a lower nuclear fuel temperature.
- Fewer components due to no steam generators and no pressurizer vessel. (Older BWRs have external recirculation loops, but even this piping is eliminated in modern BWRs, such as the ABWR.)

- Lower risk (probability) of a rupture causing loss of coolant compared to a PWR, and lower risk of a severe accident should such a rupture occur. This is due to fewer pipes, fewer large diameter pipes, fewer welds and no steam generator tubes.
- Measuring the water level in the pressure vessel is the same for both normal and emergency operations, which results in easy and intuitive assessment of emergency conditions.
- Can operate at lower core power density levels using natural circulation without forced flow.
- A BWR may be designed to operate using only natural circulation so that recirculation pumps are eliminated entirely. (The new ESBWR design uses natural circulation.)

Disadvantages

- Complex operational calculations for managing the utilization of the nuclear fuel in the fuel elements during power production due to "two phase fluid flow" (water and steam) in the upper part of the core (less of a factor with modern computers). More in core nuclear instrumentation is required.
- Much larger pressure vessel than for a PWR of similar power, with correspondingly higher cost. (However, the overall cost is reduced because a modern BWR has no main steam generators and associated piping.)
- Contamination of the turbine by fission products.
- Shielding and access control around the steam turbine are required during normal operations due to the radiation levels arising from the steam entering directly from the reactor core. Additional precautions are required during turbine maintenance activities compared to a PWR.
- Control rods are inserted from below for current BWR designs. There are two available hydraulic power sources that can drive the control rods into the core for a BWR under emergency conditions. There is a dedicated high pressure hydraulic accumulator and also the pressure inside of the reactor pressure vessel available to each control rod. Either the dedicated accumulator (one per rod) or reactor pressure is capable of fully inserting each rod. Most other reactor types use top entry control rods that are held up in the withdrawn position by electromagnets, causing them to fall into the reactor by gravity if power is lost (Sawah, 2011).

7.4.1.2 Pressurized heavy water reactor (PHWR)

The PHWR reactor design has been developed in Canada and is called the “Canadian Deuterium Uranium” or CANDU. The CANDU reactor uses heavy water (deuterium oxide, D_2O) as coolant and moderator. D2O is a more efficient moderator than regular water and as such can use natural uranium oxide (0.7% U-235) as fuel. The PHWR produces more energy per kilogram of fuel than other designs, but also produces a much larger amount of used fuel per unit output. The CANDU reactor design is similar to that of the PWR employing the use of a pressurized primary circuit and a secondary circuit, but instead of a large pressure vessel, the uranium fuel is placed in hundreds of horizontal pressure tubes (called channels). The average power density is about 10% that of a PWR, which means that for a similar energy output the reactor and its containment are correspondingly larger in size.
Newer PHWR designs such as the Advanced Candu Reactor (ACR) have regular water cooling and use lightly-enriched fuel to increase the power density and the burn up of the fuel, resulting in reduction in size and spent fuel inventory compared to current PHWR designs. (Waltham, 2011) and. (IAEA, 2002).

Advantages

The major advantage of this reactor is that the fuel need not be enriched.

- The reactor vessel may be built to withstand low pressure, therefore, the cost of the vessel is less.
- No control rods are required, therefore, control is much easier than other types. The moderator can be kept at low temperature which increases its effectiveness in slowing down neutrons.
- Heavy water being a very good moderator, this type of reactor has higher multiplication factor and low fuel consumption.
- A shorter period is required for the site construction compared with PWR and BWR.

Disadvantages

- The cost of heavy water is extremely high
- The leakage is a major problem as there are two mechanically sealed closures per fuel channel. Canadian designs generally are based or recovering high proportion of heavy water leakages as absolute leak-tightness cannot be assured.
- Very high standard of design, manufacture inspection and maintenance are required.
- The power density is considerably low (9.7 kW/litre) compared with PWR and BWR, therefore, the reactor size is extremely large.

7.4.2 Radioactive Waste Management Alternatives

7.4.2.1 Geological Disposal

The process of geological disposal centres on burrowing nuclear waste into the ground to the point where it is out of human reach. There are a number of issues that can arise as a result of placing waste in the ground. The waste needs to be properly protected to stop any material from leaking out. Seepage from the waste could contaminate the water table if the burial location is above or below the water level. Furthermore, the waste needs to be properly fastened to the burial site and also structurally supported in the event of a major seismic event, which could result in immediate contamination. Also, given the half-life noted above, a huge concern centres around how feasible it would be to even assume that nuclear waste could simply lie in repository that far below the ground. Concerns regarding terrorism also arise. (Mank, 2003)

7.4.2.2 Reprocessing

Reprocessing has also emerged as a viable long term method for dealing with waste. As the name implies, the process involves taking waste and separating the useful components from those that are not as useful. Specifically, it involves taking the fissionable material out from the irradiated nuclear fuel. Concerns regarding re-processing have largely focused around nuclear proliferation and how much easier re-processing would allow fissionable material to spread (A. Andrews, 2008)

7.4.2.3 Transmutation

Transmutation also poses a solution for long term disposal. It specifically involves converting a chemical element into another less harmful one. Common conversions include going from Chlorine to Argon or from Potassium to Argon. The driving force behind transmutation is chemical reactions that are caused from an outside stimulus, such as a proton hitting the reaction materials. Natural transmutation can also occur over a long period of time. Natural transmutation also serves as the principle force behind geological storage on the assumption that giving the waste enough isolated time will allow it to become a non-fissionable material that poses little or no risk (Charalambus, 1971)

7.4.2.4 Space Disposal

Space disposal has emerged as an option, but not as a very viable one. Specifically, space disposal centres around putting nuclear waste on a space shuttle and launching the shuttle into space. This becomes a problem from both a practicality and economic standpoint as the amount of nuclear waste that could be shipped on a single shuttle would be extremely small compared to the total amount of waste that would need to be dealt with. Furthermore, the possibility of the shuttle exploding en-route to space could only make the matter worse as such an explosion would only cause the nuclear waste to spread out far beyond any reasonable measure of control. The upside would centre around the fact that launching the material into space would subvert any of the other issues associated with the other disposal methods as the decay of the material would occur outside of our atmosphere regardless of the half-life (J. Coopersmith, 2005)

7.4.2.5 Sea Disposal

Disposal at sea involves radioactive waste being dropped into the sea in packaging designed to either: implode at depth, resulting in direct release and dispersion of radioactive material into the sea; or sink to the seabed intact. Over time, the physical containment of containers would fail, and remaining radionuclides would be dispersed and diluted in the sea. Further dilution would occur as the radionuclides migrated from the disposal site, carried by currents. The number of radionuclides remaining in the seawater would be further reduced both by natural radioactive decay and by the removal of radionuclides to seabed sediments by the process of sorption.

This method is not permitted by a number of international agreements. The application of the sea disposal of LLW and ILW has evolved over time from being a disposal method that was actually implemented by a number of countries, to one that is now banned by international agreements. Countries that have at one time or another undertaken sea disposal using the above techniques include Belgium, France, Germany, Italy, the Netherlands, Sweden, Switzerland, and the UK, as well as Japan, South Korea, and the USA. This option has not been implemented for HLW.

8 CHAPTER SEVEN: PROPOSED MITIGATION MEASURES

8.1 Introduction

This chapter outlines recommendations/mitigation measures towards a general environmental and social management framework that will contribute to sustainability in the sector. While the majority of the proposed nuclear sector interventions are anticipated to have positive economic impacts and the livelihoods of local communities, some of the PPPs may have inherent environmental and social risks as identified in this SESA report. This chapter groups key recommendations from the study into the following themes: -

- Institutional and environmental policy recommendations
- Social and economic recommendations
- Occupational safety and health recommendations
- Special scientific and socio-economic studies recommended
- Recommendations on development of typical nuclear power infrastructure

8.2 Institutional and Environmental Policy Recommendations

a) Establishment of a nuclear regulatory body: international standards and guidelines give provision to countries setting up maiden NPP to establish an independent regulator for nuclear energy. Due to safety history of jeopardy towards regulators in the past, it is therefore prudent for nuclear regulator in Kenya to absolutely independent of the nuclear operator and owner, in this case being NuPEA.

According to the, Nuclear Regulatory Act, 2019; which has established the Kenya Nuclear Regulatory Authority is proposed with a distend mandate. The mandate of the proposed Commission would however need to be aligned with the international provisions on as per IAEA Series No. GS-R-1 (IAEA, 2000). Among the key provisions of vital independence to the Commission is the development of National Policies and Regulatory Frameworks on Nuclear Energy, Radioactive Waste Management, Spent Fuel Management among others.

According to Energy Act 2019 NuPEA shall propose Policies, Strategies and Legal Structures that would guide its operations because it gives forth conflicting interests that may jeopardize the NPP legal enforcement and regulation in the future. This function should solely be done by the regulator in consultation with other key stakeholders such as NEMA, ERC, DOSHS and UoN.

b) Progress towards ratification and adoption of international legal structures: The decision to launch a nuclear power programme involves a commitment not only at national but also at international level. It is essential that Kenya becomes part of the global nuclear safety regime and share responsibility for its sustainability by Joining international treaties and conventions and ratifying to their provisions. The ratification of international instruments facilitates access to international assistance (technical, regulatory, financial, etc.) and international cooperation provides the platform to exchange information and experience, assurance of fuel supply and spare parts. Key Conventions which Kenya would need to party to and ensure domestication of their provisions include:

- The 1963 Vienna Convention on Civil Liability for Nuclear Damage (as amended by the 1997 Protocol to amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage); and
- The Convention on Supplementary Compensation for Nuclear Damage.

- *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency*:- sets out an international framework for co-operation among Parties and with the IAEA to facilitate prompt assistance and support in the event of nuclear accidents or radiological emergencies
- *Convention on Nuclear Safety:*- to legally commit participating States operating land-based nuclear power plants to maintain a high level of safety by setting international benchmarks to which States would subscribe
- *Convention on the Physical Protection of Nuclear Material:*- obliges Contracting States to ensure during international nuclear transport the protection of nuclear material within their territory or on board their ships or aircraft
- *Convention on Early Notification of a Nuclear Accident or Radiological Emergency :*- establishes a notification system for nuclear accidents that have the potential for international transboundary release that could be of radiological safety significance for another State
- *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management*: - is the first legally binding international treaty on safety in these areas. It represents a commitment by participating States to achieve and maintain a consistently high level of safety in the management of spent fuel and of radioactive waste as part of the global safety regime for ensuring the proper protection of people and the environment

c) Finalizing the formulation and adoption of the Development of Policy on Spent Fuel and Radioactive Waste Management (RWM): - RWM under the nuclear regulations part XII section 73 (1) on radioactive waste and spent fuel management states that the Act shall apply to the management of any radioactive waste and spent fuel resulting from civilian applications in the Republic of Kenya with application of the following principles at all stages in the management of radioactive waste (a) that people, property and the environment are adequately protected against radiological and other hazards; (b) generation of radioactive waste is kept to the minimum practicable; (c) interdependence among the different steps of radioactive waste and spent fuel management is taken into account; (d) protective measures for radioactive waste and spent fuel management in the Republic of Kenya are implemented in a manner that reflects internationally recognized criteria, standards and guidance; (e) biological, chemical and other hazards that may be associated with radioactive waste and spent fuel management are adequately addressed; (f) criticality and removal of residual heat generated during radioactive waste and spent fuel management are adequately addressed; (g) actions imposing reasonably predictable impacts on future generations greater than those permitted for the current generation are avoided; and (h) appropriate funding arrangements are in place.

With the plans to venture into NPP, the government therefore through relevant authorities guided by NEMA, KNRA, Institute of Nuclear Science-UoN, KEBs and NuPEA need to formulate a working policy on management of Spent Fuel and Radioactive Waste.

The National Policy will be formulated on the principles of: - sustainable development, polluter pays' principle, transparency, stakeholder and public participation and in coherence and compliance with relevant, national and international legislation and regulatory framework. The Policy will have defined goals and requirements that need to be developed before commencement of actual NPPs activities. The National Policy and strategy will: -

- Be a guide for the preparation, legislation and regulation on management of spent fuel and radioactive waste;
- Define institutional roles and responsibilities for ensuring the safe management of spent fuel and radioactive waste at the national level and county levels;

- Kick-start development of national spent fuel and radioactive waste management strategies.
- Beginning point for inclusion of nuclear provisions into the existing relevant national legal and regulative structures on: energy; land; water; environmental management, occupational health and safety; national health; and the national practices towards compliance.
- Provide for the safety and sustainability of radioactive waste management over generations, and for the adequate allocation of financial and human resources over time.
- Enhance public confidence in relation to spent fuel and radioactive waste management.

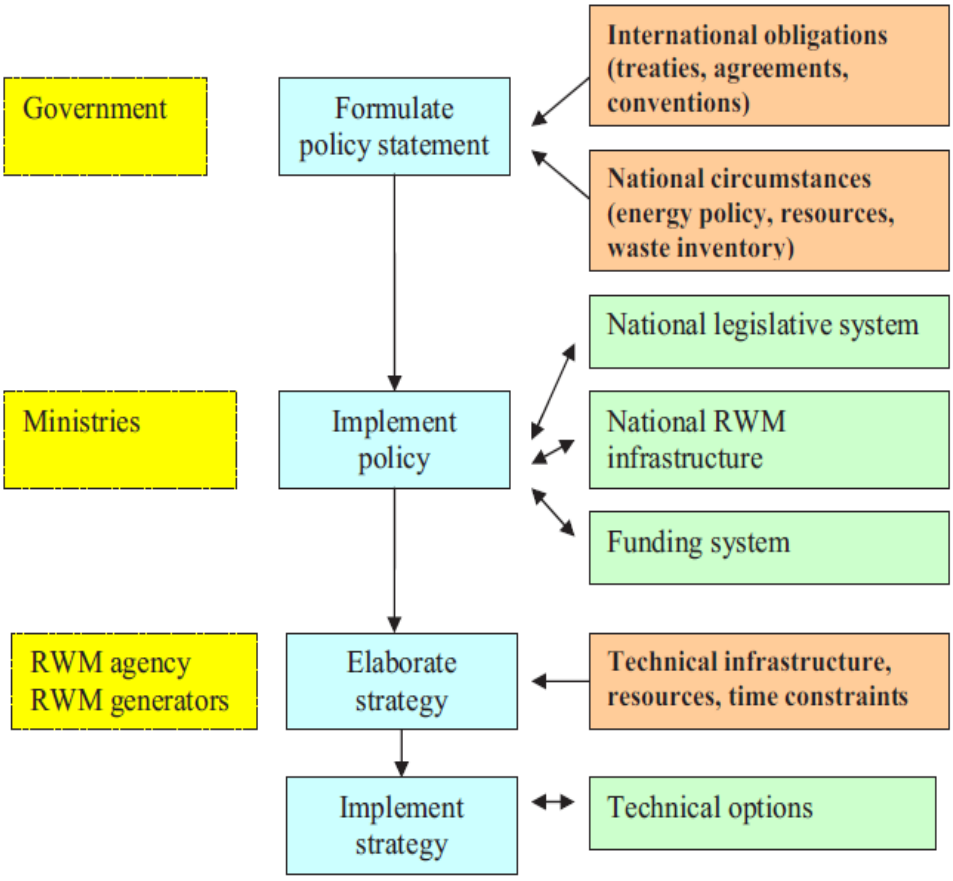

Figure 8-1: The principal steps in the development and implementation of a radioactive waste management (RWM) policy and strategy.
Source: (IAEA, 1995)

Additionally, IAEA 1995, lists a number of principles (Table 8-1: Principles in the development of a radioactive waste system) in the development of a radioactive waste system in any of its member states as stated below: -

Table 8-1: Principles in the development of a radioactive waste system

Principle	Objective
Principle 1: Protection of human health	Radioactive waste shall be managed in such a way as to secure an acceptable level of protection for human health.
Principle 2: Protection of the environment	Radioactive waste shall be managed in such a way as to provide an acceptable level of protection of the environment.
Principle 3: Protection beyond national borders	Radioactive waste shall be managed in such a way as to assure that possible effects on human health and the environment beyond national borders will be taken into account.
Principle 4: Protection of future generations	Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today.
Principle 5: Burdens on future generations	Radioactive waste shall be managed in such a way that will not impose undue burdens on future generations.
Principle 6: National legal framework	Radioactive waste shall be managed within an appropriate national legal framework including clear allocation of responsibilities and provision for independent regulatory functions.
Principle 7: Control of radioactive waste generation	Generation of radioactive waste shall be kept to the minimum practicable level.
Principle 8: Radioactive waste generation and management interdependencies	Interdependencies among all steps in radioactive waste generation and management shall be appropriately taken into account.
Principle 9: Safety of facilities	The safety of facilities for radioactive waste management shall be appropriately assured during their lifetime

Source: (IAEA, 1995)

In view of this it is prudent for Kenya to put in place an integrated national waste management system with the following key recommendations on radioactive waste: -

- The producers of the wastes have to be registered as such by the regulatory authorities in each country. They are generally responsible for the management of wastes, but in some cases, particularly for producers of small quantities, the responsibility may be passed on to other competent bodies.
- The waste repository operators accept the waste packages delivered to them from waste producers and they are responsible for the disposal.
- The regulatory authorities are responsible for the development of the regulatory framework, the control of its implementation and for the licensing of facilities, including those for waste management and disposal.
- The governments are responsible for national radioactive waste management policies and are ultimately responsible for the long term safety disposal.

In this view therefore, there is need for integration and mainstreaming of IAEA recommendations into the local policy, legal and institutional framework with reference to the IAEA's Specific Safety Requirements (No. SSR-5) on Standards for Disposal of Radioactive waste.

d) Formulation of Spent Fuel and Radioactive Waste Management strategies: Formulation of strategies will adequately operationalize the Policy Developed: - The strategies will set declared national goals and requirements for the safe management of spent

fuel and radioactive waste. These will then be translated into a more practical and operational form or strategy to provide for their implementation. Strategies will be needed to:

- Specify how the national radioactive waste management and spent fuel policy will be implemented by the responsible organizations using the available technical measures and financial resources.
- Define how and when the identified goals and requirements will be achieved.
- Identify the competencies needed for achieving the goals and how they will be provided.
- Elaborate the ways in which the various types of radioactive waste in the country, including, where appropriate, spent fuel, will be managed during all phases of the radioactive waste life cycle (from cradle to grave).
- Enhance public confidence in relation to the subject of spent fuel and radioactive waste management.

The strategies will adequately assess radioactive waste sources, types and streams; establish radioactive waste inventories according to their classification; assessment of resources (human, technical and financial); and identify issues and gaps of the existing RWM.
Some of the strategies for consideration in management of Spent fuel are: Long term storage for disposal; Reprocessing and recycling then disposal; direct disposal; Fuel Leasing/ Fuel take back and Retention of spent fuel as a valuable commodity

Lastly, in development of RWM strategies, the following RWM would be prudent through this framework: -

- Identification of all site- specific waste streams
- Identification of end point for each waste stream
- Identification of waste processing options for each stream and steps for each option
- Evaluation and selection of options in well balances systematic way.
- Stakeholder involvement and acceptance of plan

The strategies shall be developed under the following RWM principles: process optimization (cradle to grave); Hierarchy for waste management options (waste prevention and minimization; clearance; re-use, reprocessing and recycling; conditioning and storage; and disposal); continual system improvement; final disposal ultimate

e) Development of Policy and strategy for decommissioning of nuclear and radiological facilities: - Decommissioning of nuclear and radiological facilities is a risky activity to community health and safety and therefore warrants a guiding national policy to way of undertaking with considerations to the local legislation and regulatory framework on decommissioning of facilities i.e. obtaining approvals from NEMA and other relevant agencies. The international standards and guidelines on decommissioning of such facilities' provisions should also be aligned to the national policy

The policy should address the following pertinent issues: -Provide protection of people and the environment both now and in the future; include a long term commitment to ensuring that sites and waste from them are properly managed; provide efficiency in the use of resources; provide for open and transparent interactions with stakeholders; and sustainability in resource use and impact.

The national arrangements for managing the radioactive waste from decommissioning will specifically be significant and should be specified in the national policy, and its interface with national policy on radioactive waste management clarified. It should clearly identify among other things: -

- The government departments or other organizations responsible for establishing the legislative and regulatory framework.
- The relevant regulatory bodies and their roles.
- The organization responsible for ensuring that the facility is decommissioned safely, effectively and in a timely manner, and that the materials generated are properly managed (normally the operator/licensee).
- Indicate the national arrangements if the operator/owner is unable to carry out these duties.
- The organization responsible for ensuring that radioactive waste is safely and effectively managed in the long term.

The role of NuPEA, NEMA and KNRA in Radioactive Waste Management will need to be specific and clear without any overlap to ensure strict compliance and enforcement.

Formulation of a national strategy consistent with the national policies for decommissioning and Radioactive Waste Management is prudent.

f) Development of National Guidelines for Environmental and Social Impact Assessment for both Nuclear Power and Radioactive Facilities and guidelines for Project Affected Persons Consultation and Stakeholder Participation: Kenya's activities in nuclear sector have been limited to academic and health sectors and therefore at a very small-scale level. Therefore, the capacity to adequately develop ESIA reports to meet required international standard as well as meeting local guidelines is wanting. It would need the registered EIA Experts who develop these reports to have requisite knowledge on nuclear operations in order to develop a report that is satisfactory to guide inform decision by NEMA and relevant lead agencies. Currently, general reports on various mega-infrastructural development lack of consistency and uniformity in the quality. The nature of the nuclear energy programme would require independent individual EIA reports for various projects under the programme across the three NPP phases. Development of guidelines therefore will be useful to reviewer's/ decision makers and EIA consultants. The EIA guidelines will also help relevant Lead Agencies understand the kind of information that is expected from them by NEMA during the stakeholder consultation process.

IAEA has developed a guideline (Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes) (IAEA, 2014) No: NG-T-3.11: on undertaking of Environmental Impact Assessments for Nuclear power plants whose provisions can be mainstreamed into the local EIA/EA guidelines and the Integrated Environmental Impact Assessment and Audit draft regulations.

g) Development of nuclear legislative structures/ domestication of international legal structures' provisions on nuclear power development: Kenya is member of the International Atomic Energy Agency and African Commission on Nuclear Energy (AFCONE) and is signatory to all the four allied convention under the IAEA and one under AFCONE. The spirit of International conventions is that, member states ought to ratify them and domesticate them into their local legal framework. Mainstreaming of the provisions of the convention into local legal structure is of high importance though enactments of new laws and amendment of the existing laws especially EMCA Cap 387 on radioactive waste management and spent fuel management; OSHA 2007 and Nuclear Regulatory Act 2019 to reflect on provisions on nuclear safety, nuclear emergency and disaster management plans. In the legal structures, development guidance shall be provided through the IAEA Handbook on Nuclear Law, (IAEA, 2003).

h) Develop an environmental management and coordination regulation for nuclear sector: Implementation of an overarching legal and regulatory framework for the nuclear power sector of vital importance to the sustainable development sector. There do exist some environmental regulations in Kenya but they scantly aspects of nuclear energy and radioactive waste management. Development of a stand-alone regulation is therefore important to cover all environmental aspects of the sector whose enforcement shall be overseen by a special department that deals with nuclear environmental issues in NEMA.

These regulations should adequately cover amongst other issues, accidental radioactive emissions management. NEMA in consultation with support local relevant agencies such KEBs, NuPEA, Nuclear Science Institute- UoN and Ministry of Health with expertise help of international organizations such IAEA should develop appropriate regulations to prevent, radioactive emissions or other forms of environmental damage that may arise from NPP operations. These regulations shall also provide for the control and prevention NPP footprint on natural resources and ecosystem services.

i) Development and implementation of a Public Participation and Consultation National Manual for Nuclear Power Sector: This will guide the development of the proposed *Community User Guide for Environmental and Social Impact Assessment* to strengthen public consultation and involvement in nuclear power sector to enhance positive public perception and NPP acceptance levels in the society.

j) Community user Guide for Environmental and Social Impact Assessment: At present, the need for consultation in national infrastructural projects is included in environmental Assessment legislation, but adequate consultation is not necessarily undertaken in all cases. The EIA experts are not guided by law or regulation on what details adequate public and stakeholder consultation and therefore many are left to their own discretion of the same. This results to lack of information about national projects to the public and reduces projects' acceptability. The adverts done through print and radio do not suffice which means much is to be done during baseline information collection as done by EIA experts.

Notably, environmental assessment reports should not be approved without inclusion of the public consultation process and its results. Consultation regarding nuclear power operations should be undertaken in a culturally appropriate manner, taking into account local customs, ethnic background, approach to business interactions, knowledge of extractive industries and their effects relative to the candidate sites, national culture values. During the study, it was discovered that communities lack information on their role and involvement in EIA process hence making public consultation inadequate.

This guide will help create awareness among the local communities and guide their participation. This guide can be incorporated in the EIA Guidelines. NuPEA can give support to NEMA to create awareness among local communities through available information systems including brochure distribution. This guide shall include matters related to free, prior, informed consent (FPIC). Consider this as a key empowerment element for community engagement and participation.

Based on international best practices and the national public participation policy framework and laws, each county should develop community-to-community consultation / engagement standard guidelines because all the 43 communities in the country have diverse cultural and traditional leadership and engagement practices. This guide will provide for Gender and Equity (Representation, compensation, employment / opportunity sharing equity) during stakeholder engagement undertakings.

k) Establishment of a Nuclear Unit at NEMA to handle all nuclear operations' environmental matters in the sector: Currently, NEMA lacks capacity on handling

environmental, health and safety issues of the nuclear sector. To fill this gap, it is recommended nuclear department/unit/ directorate that all other government agencies (especially DOSH, ERC, Kenya Police, , MoH among others) as per EMCA, Cap 387. This will promote efficiency in EIA projects reports review, EIA Site verification visits, EIA follow-up and monitoring, inspection and prosecutions. Capacity building efforts on regulating the nuclear sector will then be focused on the officers deployed in the department/unit/ directorate.

Whereas lead agencies have responsibilities meant to give effect to EMCA Cap 387, there appears to be either a misunderstanding of how other statutes should give effect to EMCA, Cap 387 or this is interpreted to mean there is overlap in mandates. To avoid this scenario in the nuclear sector, which is very sensitive, there is need to study the mandates and responsibilities of the different organizations involved in addressing environmental concerns in reference to their relationship with NEMA and draw the interrelationship structure. A policy and legal framework on the same should be developed to support their operations. It would be important specially to delineate, roles clearly between the nuclear energy regulator, ERC, NEMA and NuPEA in order to avoid disasters such as the Fukushima disaster due to vested interests across stakeholders.

l) Develop Spent Fuel and Radioactive Waste Management user's guide based on local and international legal procedures and environmental standards: A guide that covers all the potential risks associated with spent fuel and radioactive waste and all possible management strategies should be developed for the relevant agencies and companies. NEMA, DOSH and should take lead. The guide should propose the most sustainable and cost-effective methods and procedures of dealing with spent fuel and radioactive waste. Guidance on development of these standards shall be sought from: - IAEA Safety Standards Principles for protecting people and environment (IAEA Safety Standards Series No. SF-1) (IAEA, 2006)***.***

m) Development of the EHS Inspection and Monitoring Procedures: There are no written coordination procedures to ensure no overlaps and duplication of effort and roles between NEMA, DOSHS,
and Ministry of Health with regard radioactive emissions and waste management. These procedures nuclear operations EHS operations would be a basic tool to guide monitoring and inspection. However, there is still need to build capacity for the National and County-based Environmental Inspectors in NEMA and other relevant Lead Agencies on use and application of this procedural manual.

n) Establishment of a special department for wayleave acquisition, record keeping, monitoring and enforcement of wayleaves encroachment: The National Land Commission should dedicate resources to this function. There is a high rate of encroachment of wayleaves/ buffer zones throughout the country which contributes to higher resettlement costs and local conflicts/grievances during project implementation. There should be guidelines to discourage settlement on buffer zones, wayleaves and establish clear demarcations between public and private land.

Any acquisition of land in the interest expanding way leaves and buffer zones should be guided by policies and plans to protect land owners. Technology such as GIS-based information should be fully utilized in keeping inventory and in monitoring. Clear regulations should also be set on how to deal with encroachment of wayleaves and buffer zones to protect communities who ignorantly occupy them from project related community health and safety impacts. This will be adequately coupled with community safety awareness and sensitization on the significance of buffer zones on key installations such as the nuclear reactor plants, and radioactive waste management plants.

o) Establish Nuclear Sector Environmental Management Information System: This SESA study identified that availability of environmental information on sector specific developments in Kenya is quite fragmented not just within the public domain, but also within the lead agencies involved in the EIA decision process. Nuclear Power being a new programme in Kenya that will attract local and international attention will need to have a well-coordinated system that can be updated on real-time on the environmental progresses in the sector. The system should be a complete feedback mechanism on public queries and suggestions The system should be among other requirements be able to provide for number of EIA reports received at NEMA, lead agencies consulted and their comments, records of decision, monitoring records, incidents reported and response, environmental audit reports received and locations of ongoing projects.

It is necessary to benchmark such systems so that an adequate infrastructure for the system is established that meets the standard of such other systems in the world, with the aid of AIEA. The system will help in storage and disclosure of all regulatory submissions such as EIAs, public disclosure of reactors in operation, the nuclear power plant ESMP conformance and life cycle programme analysis.

The system should put together all necessary licences, approvals, permits required for the NPPs sector. It should be developed in phases where Phase one would involve studying all the information relevant for the nuclear sector in NEMA including operations involved, undertake comparative studies on other similar system models in countries involved in nuclear sector development where such systems exist and recommend the most applicable system design. Phase two would involve finalization of the proposed design (prototype) and establishment and capacity building on use of the system. This should also act as a national and county reference point for all information on legal provisions and requirements in the country.

This will need an Inter-ministerial/Agency Coordinating Committee, since the nuclear sector development is too complex and should be developed in an environmentally sound and socially acceptable manner. The committee should be made up of government representatives to ensure coordination and information dissemination. This committee should be made up of Government institutions involved in the nuclear sector development like KNRA, ERC, NuPEA, and Environmental, Safety and Health Regulatory Agencies like NEMA and DOSHS. Due to the inherent nature of the nuclear power programme and threats like cyber-attacks and proliferation, there should strong and tested firewalls upon the system, with key essential and classified information abstracted from the General User Interface.

p) Lead Agencies Capacity Building and Inter-Agency Coordination including Streamlining Environmental Roles and Responsibility: There is need for development of a capacity building programme for NEMA and key public sector institutions. This will strengthen institutional capacity in environmental management of the nuclear sector industry; and improve or build capacity on EIA follow-up, monitoring mechanisms and information dissemination to ensure enforcement and compliance to relevant legislation.

The Government of Kenya take steps to clearly define the institutional structure for environmental management, whereby NEMA is the competent authority responsible for establishing the national environmental policy, while sectoral Environmental Departments within other ministries are responsible for the policy's implementation and sectoral environmental regulation formulation.

An inter-Agency Environmental Monitoring Committee should be established to ensure effective follow-up, monitoring and compliance with established government policy and legal instruments. Since NEMA consults other relevant lead agencies for opinions towards decision making on EIA reports, if the lead agencies do not have any background understanding or

basic information on the nuclear sector, their sectoral based opinions on EIAs will be inadequate also noting that these lead agencies play a key role in monitoring. It is therefore important to put in place a capacity building programme for lead agencies. Horizontal communication pathways should be maintained because they are critical in reporting and development of information sharing of protocols

q) Integration of Health Impact Assessment into the EIA Process: Health Impact Assessment of the nuclear based projects will be vital. This will provide way for collected baseline information on health of project affected persons before project implementation for ease future project impact monitoring on health.

r) Conservation of habitats: Support Mapping of Protected Sites- Ensure Linkages to Wise Use of Water and Protection of Water Bodies and Wetlands: Nuclear Power Programmes are water intensive ventures all through the NPP phases as identified in previous chapters. This will thus necessitate development of a sectoral policy with regard to water use and management in relation to the nuclear activities. Secondly, the NEMA Water Quality Regulations, 2006 should be adequately amended to include aspects of management of water and effluents in the NPP programme. Thirdly, comprehensive water need assessment needs to be done for all the candidate sites, with a comparative look into reserves' capacity, current water need and simulation of water need and usage upon adoption and implementation of the NPP.

Finally, NEMA in collaboration with WMA should develop technical guidelines for nuclear power operations within the selected candidate sites i.e. Lake Victoria Basin, The Coastline and the Lake Turkana Basin and wetlands. The same guidelines should cover groundwater resources (see, IAEA guidelines: No. NP-T-2.6- Efficient Water Management in Water Cooled Reactors) (IAEA, 2012).

s) Conservation of habitats: Support mapping of protected area and development of updated maps in proximity to the candidate sites: This would mainly cover protected forests, wildlife, fish breeding sites (biodiversity hotspots) and UNESCO listed sites. KWS, KFS, WMA, NMK and NEMA shall take the lead in this activity. All sensitive habitats, animal migratory routes and fish breeding grounds may be studies, mapped and Gazetted to control human developments and for preservation of these ecological sites for future generations. Relevant government lead agencies should develop technical guidelines for nuclear power activities in protected forests, Important Bird Areas (IBAs) and wildlife areas. Ecologically sensitive areas with irreversible negative impacts should be avoided

t) Environmental Conservation Plans: All water basins in the country are at risk due to pressure from competing uses. Existing Environmental Conservation Plans for the candidate sites (water basins) should be implemented before the commencement of the NPP's infrastructure development; The plans should be developed through an integration of total ecosystem considerations as a way of conservation of biological diversity and promotion of sustainable development. There is need to map/ zone and protect the fish breeding grounds from potential thermal dynamics in water basins will need to be developed. Maps showing the current pollution, water temperature levels in the water basins will need also be developed for measurement and monitoring of temporal scale dynamics on given key parameter.

u) Capacity building on Heritage Impact Assessment: In Kenya, there are protected areas like heritage sites with archaeological and cultural importance while others are designated as protected areas/national monuments under the National Museums and Heritage Act, 2006. On a general scope, a few areas within the candidate basins have been listed with UNESCO as places of cultural heritage importance such as the Lamu Old Town, the Lake Turkana Basin and Ohingo within the Lake Victoria Basin.

To avoid interference with these areas, the importance of Heritage Impact Assessment before approval of NPP sector projects should be recognized hence it should be made a requirement under Environmental (Impact Assessment/Audit) Regulations. NEMA should work closely with NMK, as a lead agency, in EIA/SESA reports reviewing before issuance of EIA Licences. This will require a comprehensive capacity development for both NEMA and NMK for integration of Archaeological Impact Assessment (AIA), Social Impact Assessment (SIA), Health Impact Assessment and Cultural Impact Assessments (CIA) into the Environmental Impact Assessment process for Nuclear Sector projects. Guidelines for preservation of cultural properties and resources, which include sites having archaeological, historical, traditional, religious and unique natural values, should be developed.

v) Review and Revision of Institutional and Legal Frameworks and Laws: Some existing institutional frameworks and laws that were enacted before, development of the Kenya Vision 2030, the 2010 constitution and devolution process require revision. Streamlining, reviewing and updating environmental policies, legal and regulatory status to ensure that the country achieves nuclear policy and legal framework sufficiently is important at this stage. For example, the development of national SESA/ SESA, EIA and Audit guidelines for the nuclear sector the regulator through the support of NEMA and other government agencies is critical. This also applies to formulation of EHS for the sector.

In the quest to create a dynamic industry, institutional transparency and accountability must be promoted. Transparency is essential in building and maintaining public dialogue and increasing public awareness about the GoK's development role and mission in the nuclear sector. It is also critical for enhancing good governance, accountability, acceptability and development effectiveness.

The harmonization of political leadership with civil society, media and other opinion shapers, as well as the private sector to pursue ethical leadership and robust public management models will contribute significantly to achieving these best practices. Empowering existing institutions tasked with providing checks and balances (for example the National Assembly, the Senate and the Judiciary), should contribute to the creation of a good fiscal decentralisation with accountability and community driven development.

All stakeholders should have a moral and constitutional duty to apply best practices in public consultation and involvement, building of sustainable partnerships and the integration of social concerns into NPP planning and design, appraisal, construction, operation and decommissioning processes. All key stakeholders of the sector must undertake management of social issues through public participation and partnerships. It is important for future investments in the sector to have community support, acceptance and informed consent as part of their foundation. The development and continuous review of existing environmental, regulatory and monitoring frameworks with determination of liability costs during decommissioning, closure, and abandonment processes, will support the sector in the long term by protecting future generations.

w) Enhancing capacity for the Institution of Nuclear Science at local universities and TVET centres: - There is need to build professional capacity in Nuclear Power development in Kenya such introduction of undergraduate degrees, Masters Degrees on just general nuclear science but in Nuclear Power Engineering, Nuclear Safety Engineering, Environment, Health and Safety in Nuclear Operations. Structural Engineering in Nuclear Energy, among others. This will ensure that there is possibility for practical skill transfer and enhancement of local nuclear power expertise.

Of essence is establishing of course on environment, health and safety at a national scale through degrees and short course to the public, stakeholders. Lead agencies and special NEMA unit for nuclear issues.

Table 8-2: Mitigation of high level environmental impacts in the KNPP below gives a summative approach to high level environmental impacts from NPP.

Table 8-2: Mitigation of high level environmental impacts in the KNPP

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
National Constitutional obligations Violation of the constitutional right on clean and healthy environment (Article 42 through risk of radioactive contamination	• The vision of the energy sector in Sessional Paper No. 4 of 2004 on Energy is to promote equitable access to quality and affordable energy while protecting the environment • S2.1.7(1) of Sessional Paper No. 4 of 2004 on Energy is to use appropriate technology in order to minimize environmental pollution • S3.1 of the Draft National Policy & Strategy for Radioactive Waste Management, 2017 prescribes that: - • The ultimate responsibility for the safety of radioactive waste and spent fuel management shall rest with the national government • The government shall establish a legal and regulatory framework including the designation of an independent regulatory body for the safe management of radioactive waste • S.3.3 prescribes that the government shall ensure that individuals, society, and the environment are protected from the harmful effects of ionizing radiation • S.3.10 prescribes that the government establish a radiation protection programme for the transport of radioactive waste	• Use of environmentally sustainable technology including type of reactor and cooling method • Establishment a Nuclear Waste Management Organization (WMO) • Establishment of a legal and regulatory framework for the safe management of radioactive waste • Establishment of an independent nuclear regulatory body • Establishment of a radiation protection programme for the transport of radioactive waste/spent fuel	•
Water Resources • Sustainable water use by the nuclear sector • Impact on water supply for future demands in agriculture, livestock, wildlife and fisheries • Impact of water supply for future domestic and industrial water demands (e.g. LAPSSET Programme) • Water competition and conflicts in	S3.3.1 of the National Nuclear Fuel Cycle Policy and Strategy, 2017 prescribes the need to set up a Waste Management Organization in charge of receiving radioactive waste and spent fuel from the nuclear power plant, including long-term spent fuel management or disposal • S5 of the indicates the aim for a long-term arrangement with reliable and responsible governments and contractors/suppliers for secure supply of nuclear fuel • S7.2 prescribes the need to initiate the early siting of geologic repositories of spent fuel in the nuclear power programme • S8 prescribes the need to develop regulations on the requirements for nuclear fuel management • S10 & 11 prescribes the requirements for on-site and away-from reactor spent-fuel storage facilities including appropriate containment of radionuclides • S3.1 prescribes that the ultimate responsibility for the safety of radioactive waste and spent fuel management shall rest with the national government through a waste management organization (WMO)	• Establish a Nuclear Waste Management Organization (WMO) • Early siting of suitable geological repositories of spent fuel • Develop regulations for nuclear fuel management • Develop regulations for on-site and away-from reactor spent-fuel storage • Establish a legal and regulatory framework for the safe management of radioactive waste • Establish an independent nuclear regulatory body	• Sustainable water use by the nuclear sector for equitable sharing with other economic sectors including inter-basin and intra-basin water transfers

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
inter-basin and intra-basin water transfers • Radioactive contamination of the water reserve (apportionment) for ecological functions and basic human needs • Radioactive contamination of water resources for existing uses - domestic, industrial and irrigation demands	• S3.1 prescribes that the government shall establish a legal and regulatory framework including the designation of an independent regulatory body for the safe management of radioactive waste • S.3.3 prescribes that the government shall ensure that individuals, society, and the environment are protected from the harmful effects of ionizing radiation		
Biodiversity & Ecosystem • Risk of radiation exposure to soil, water and biodiversity • Radiation exposure to the aquatic flora and fauna including waterfowl • Accidental radiation exposure to migratory wildlife • Radioactive contamination in rivers, lakes and wetlands	S3.3.1 of the National Nuclear Fuel Cycle Policy and Strategy, 2017 prescribes the need to set up a Waste Management Organization in charge of receiving radioactive waste and spent fuel from the nuclear power plant, including long-term spent fuel management and disposal • S7.2 prescribes the need to initiate early siting for geologic repositories of spent fuel • S8 prescribes the need to develop regulations on the requirements for nuclear fuel management • S10 & 11 prescribes the requirements for on-site and away-from reactor spent-fuel storage including appropriate containment of radionuclides • S3.1 prescribes that: - • The ultimate responsibility for the safety of radioactive waste and spent fuel management shall rest with the national government through a waste management organization (WMO) • The government shall establish a legal and regulatory framework including the designation of an independent regulatory body for the safe management of radioactive waste	• Develop regulations on radiation protection • Establish a legal and regulatory framework for the safe application nuclear technology • Establish an independent nuclear regulatory body • Establishment of a nuclear liability regime	• Sustainable water-use by the nuclear sector to avoid the shrinkage of wetland ecosystems • Preservation of national conservation areas including wildlife corridors and dispersal areas

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
• Degradation of mangrove and coral ecosystems • Impact on deltaic ecosystems • Impact on wetland ecosystems, species and habitats • Wetland shrinkage due to increased water abstraction • Radioactive contamination of the national protected areas (NPAs) including private and community conservancies • Impact on ecosystem services	• S.3.3 prescribes that the government shall ensure that individuals, society, and the environment are protected from the harmful effects of ionizing radiation		
Environmental protection and restoration • Environmental restoration • Environmental restoration fund	• S2.1.7(1) of Sessional Paper No. 4 of 2004 on Energy requires all new energy projects to be subjected to comprehensive EIA • S5.8(1) recognizes the crucial need for environmental protection • S5.8(2) recognizes the need for effective environmental rehabilitation on project completion or abandonment • S7.2 of the National Nuclear Fuel Cycle Policy and Strategy, 2017 prescribes the need for early siting for geologic repositories of spent fuel early enough in the nuclear power programme • S8 prescribes the need to develop regulations on the requirements for nuclear fuel management • S10 & 11 prescribes the requirements for on-site and away-from reactor spent-fuel storage including appropriate containment of radionuclides • S3.1 prescribes that: -	• Each individual NPP project will be subjected to comprehensive ESIA in accordance with EMCA Cap 387 • Early siting of suitable geologic repositories of spent fuel • Developing regulations for nuclear fuel management • Developing regulations for on-site and away-from reactor spent-fuel storage • Establishing a Nuclear Waste Management Organization (WHO) • Establishing a legal and regulatory framework for the safe application management of radioactive waste	• Nuclear plant decommissioning and environmental restoration • Environmental restoration funding

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
	• The ultimate responsibility for the safety of radioactive waste and spent fuel management shall rest with the national government through a waste management organization (WMO) • The government shall establish a legal and regulatory framework including the designation of an independent regulatory body for the safe management of radioactive waste • S.3.3 prescribes that the government shall ensure that individuals, society, and the environment are protected from the harmful effects of ionizing radiation • Part VIII Safeguards S. 88 prescribes that any person intending to carry out research and development activities related to the nuclear fuel cycle, shall prior to commencement, provide to the Authority information and data necessary for compliance subject to the Safeguards Agreement or any protocol thereto. • Convention on physical protection of nuclear material – that purposes to achieve and maintain worldwide effective physical protection of nuclear material & of nuclear facilities used for peaceful purposes; to prevent and combat offenses relating to such materials and facilities worldwide; to facilitate corporation among states parties to those ends	• Establishing an independent regulatory body for the safe management of radioactive waste	
Multi-lateral Environmental Agreements	• Article 19: -Protocol on environment & natural resources, 2006 shall: - • a. Adopt common policies and mechanisms to promote the efficient exploitation, development and utilization of various energy resources available within the region; • b. Promote the development and transmission of electric power, development of integrated policy on rural electrification, and inter-connection of Partner States' electrical grids; • c. Ensure the implementation of the regional programmes which facilitate trade and industrialisation and stimulate sustainable rural development through rural electrification • Article 2.4 of the Ramsar convention focuses on the promotion of conservation of wetlands and Article 3.2 states that parties have committed to be informed at the earliest possible time if the ecological character in its territory/included in the list is changing/likely to change as a result of technological developments, pollution or other human interference.	• Integration of conservation measures for protection of migratory species and wetland into the nuclear regulations • Alignment to the EAC Environment and Natural Resources Protocol • Alignment to the Nairobi Convention on radioactive contamination of coastal and marine environment • Alignment to the Law of the SESA & IAEA agreements • Alignment to the Ramsar Convention Alignment to the CMS (Bonn Convention)	• Integration of MEAs in the nuclear programme frameworks

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
	• Article IV & V of the Bonn convention focuses international cooperation is required for conservation and management of migratory species as listed in the articles.		
Health and safety • Nuclear fear and social stigma • Impact of social stigma on fishery and tourism sectors • Emergency relocations to safe areas	S2.1.7(1) of Sessional Paper No. 4 of 2004 on Energy aims at ensuring measures for mitigating environmental, health and safety impacts to minimize the adverse impact of all energy programmes and projects • S2.2 of the National Policy & Strategy for Safety in Kenya, 2015 obligates the government to: - • Ensure that the fundamental safety objective is applied for all facilities and activities and for all stages over the lifetime of a facility or radiation source including the associated transport of radioactive material and management of radioactive waste • Observe the ten (10) IAEA safety principles that are applicable throughout the entire lifetime of all facilities and activities in the NPP including the following: - • Developing provisions for ensuring that the prime responsibility for safety shall rest with the person or organization responsible for facilities and activities that give rise to radiation risks according to Principle 1: Responsibility for safety. • Developing regulations specifying the extent to which the licensee shall bear liability in the event of an accident. • Establishing and sustaining an effective legal framework, regulations and standards for nuclear safety, including establishment of an independent regulatory body according to Principle 2: Role of Government. • Identifying a regulatory body and responsible authorities to ensure there are programmes of actions to reduce radiation risks, including actions in emergencies, for monitoring releases of radioactive substances to the environment and for disposing of radioactive waste. • Identifying a regulatory body to ensure that effective leadership and management for safety is established and sustained in organizations concerned according to Principle 3: Leadership and management for safety. • Providing measures for controlling radiation risks will be applied to ensure that no individual bears an unacceptable risk of harm according to Principle 6: Limitation of risks to individuals	• Integration of the conservation measures for protection of migratory species in the nuclear regulations Integrating all the highlighted environmental, health and safety impacts • Establishing a Nuclear Waste Management Organization • Developing regulations for on-site and away-from reactor spent-fuel storage • Establishing a legal and regulatory framework for the safe management of radioactive waste • Establishing an independent regulatory body for the safe management of radioactive waste • Develop provision that ensure that the prime responsibility for safety shall rest with the person or organization responsible for facilities and activities that give rise to radiation risks • Developing regulations will be developed specifying the extent to which the licensee shall bear liability in the event of an accident • Establishing and sustaining an effective legal framework, regulations and standards for safety, • Establishing an independent regulatory body • Identifying a regulatory body and responsible authorities to ensure there are programmes of actions to reduce radiation risks	• Nuclear fear and social stigma

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
	• Establishing provisions to protect people and the environment, present and future against radiation risks according to Principle 7: Protection of present and future generations. • Developing a waste management plan that includes a funding arrangement to be considered in phase 1 and further developed in phase 2 of nuclear programme development. • Making all practical efforts to prevent and mitigate nuclear or radiation accidents by ensuring legal measures are taken to prevent the occurrence of failures or abnormal conditions (including breaches of security) that could lead to loss of control over a nuclear reactor core, a radioactive source or other source of radiation according to Principle 8: Prevention of accidents. • Establishing legal measures with primary goals of preparedness for and response to a nuclear or radiation emergency according to Principle 9: Emergency preparedness and response. • Ensuring that protective actions to reduce existing or unregulated radiation risks will be justified and optimized according to Principle 10: Protective actions to reduce existing or unregulated radiation risks • S3.1 prescribes that: - • The ultimate responsibility for the safety of radioactive waste and spent fuel management shall rest with the national government through a waste management organization (WMO). • The government shall establish a legal and regulatory framework including the designation of an independent regulatory body for the safe management of radioactive waste • S.3.3 prescribes that the government shall ensure that individuals, society, and the environment are protected from the harmful effects of ionizing radiation • S3.3.1 prescribes the need to set up a Waste Management Organization (WMO) in charge of receiving radioactive waste and spent fuel from the nuclear power plant, including long-term spent fuel management or disposal • S.3.13 prescribes that the government and relevant licensees (waste owners) shall strive to inform the public about all proposed plans for radioactive waste/spent fuel management, and to consult concerned parties and members of the public in decision making processes	• Identifying a regulatory body to ensure that effective leadership and management for safety • Providing measures for controlling radiation risks • Establishing provisions to protect people and the environment, present and future against radiation risks • Developing a nuclear waste management plan • Providing legal measures to prevent and mitigate nuclear or radiation accidents • Establishing legal measures with primary goals of preparedness for and response to a nuclear or radiation emergency. • Establishment of a continuous public education and awareness programme by NuPEA.	

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
	• S4.1.2(c3) recognizes the need for careful preparedness in the handling of critical issues on environment, health and safety without rush • S10 & 11 prescribes the requirements for on-site and away-from reactor spent-fuel storage including appropriate containment of radionuclides • S4.11(a) prescribes that public attitudes and expectations in relation to the potential construction of radioactive waste management facilities should be understood and addressed • S9.1 & 9.13 of the National Policy & Strategy for Safety in Kenya, 2015 obligates the government to develop a legal, regulatory and institutional framework and a policy and strategy for allocation of roles for Nuclear Emergency Preparedness and Response • S5.1 and 6 of the Nuclear Regulatory Act, 2019 emphasises the safe, secure and peaceful use of nuclear science and technology. • Protection of persons, property and the environment against the harmful effects of ionizing radiation through the establishment of a system of regulatory control, controlling (i) siting, design, construction, operation, manufacture of component parts and decommissioning of facilities and (ii) establishing appropriate mechanisms and procedures for informing and consulting the public and other interested parties about the regulatory process and the safety, health and environmental aspects of regulated activities including incidents, accidents and abnormal occurrences • S53.2(1) of the Act gives provisions for regulatory control for radiation protection • S53.2(2) of the Act gives provisions for radiation protection requirements • S58(1) and 59 of the Act give provisions for establishment of regulations for transportation of radioactive material in accordance with international standards.		
Economic impacts • Loss of livelihoods and economic opportunities • Negative impacts on fisheries, tourism and local	• S4.1.2(C3) of Sessional Paper No. 4 of 2004 on Energy recognized the need for Kenya to seriously consider the economic merit order of nuclear power generation in relation to other cheaper sources	• Developing livelihood restoration strategies for communities likely to be negatively impacted	

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
production systems • Impact on the Blue Economy Agenda			
Health impacts • Long-term radiation related health complications • Radiation related healthcare	S3.3.1 of the National Nuclear Fuel Cycle Policy and Strategy, 2017 prescribes the need to set up a Waste Management Organization in charge of receiving radioactive waste and spent fuel from the nuclear power plant, including long-term spent fuel management or disposal • S8 prescribes the need to develop regulations on the requirements for nuclear fuel management • S10 & 11 prescribes the requirements for on-site and away-from reactor spent-fuel storage including appropriate containment of radionuclides S3.1 prescribes that: - • The ultimate responsibility for the safety of radioactive waste and spent fuel management shall rest with the national government through a waste management organization (WMO) • The government shall establish a legal and regulatory framework including the designation of an independent regulatory body for the safe management of radioactive waste • S.3.3 prescribes that the government shall ensure that individuals, society, and the environment are protected from the harmful effects of ionizing radiation	• Establishing a Nuclear Waste Management Organization • Developing regulations for nuclear fuel management • Developing regulations for on-site and away-from reactor spent-fuel storage • Establishing a legal and regulatory framework for the safe management of radioactive waste • Establishing an independent regulatory body for the safe management of radioactive waste	
Security • Illegal acquisition and transfer of uranium materials • Risk of nuclear related terrorism	S3.1 of the National Nuclear Fuel Cycle Policy and Strategy, 2017 prescribes that: - • The nuclear regulator will regulate the safe management of radioactive waste. • S3.3 prescribes that the government shall ensure that adequate physical protection measures are taken to prevent unauthorized access to and/or unauthorized removal of radioactive waste/spent fuel S5 indicates that: - • Kenya shall diversify it sources of fuel supply, keep/have an inventory of fresh fuel bundles at the site and secure uranium mainly through long-term contracts with minor portion through mid-term contract and spot purchase.	Establishment of State System of Accounting and Control of Nuclear Materials (SSAC).	
Nuclear disaster • Nuclear disaster impacts	• S5.7.1(c1) of Sessional Paper No. 4 of 2004 on Energy recognizes the need for appropriate disaster preparedness and mitigation measures to address the vulnerability of energy infrastructure by freak weather and	• The NPP will consider all the hazard and disaster management dimensions.	• Public education and awareness on nuclear disasters

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
• Radioactive related health impacts from nuclear disasters due to poor early warning • Public radioactive exposure from nuclear accidents	climate changes, sabotage, human error or technological failure and its potential to affect large populations and the environment S5.7(2) identifies the various hazards that lead to energy disasters which must be taken into consideration in planning and management of the energy sector: • Climate and weather hazards including floods, droughts, all types of storms, weather and climate extremes. • Geophysical hazards including earthquakes, landslides, volcanic activity and mudflows. • Environmental hazards including erosion, desertification, wild-fire and infestation. • Technological hazards including accidental chemical or industrial release, structural or infrastructural systems failure. • Human negligence hazards like fires and system stress, which lead to structural or infrastructural failure; and, • Vandalism and theft of energy installations • S5.7(3) recognizes a challenge in the establishment of a national capacity for predicting and where possible preventing disasters before they occur • S6.6.8(1) prescribes the need for establishing early warning systems in all energy sub-sectors including: - disaster management and response units, well-coordinated central commands, effective functional hazard monitoring systems, mainstreaming weather and climate data and information, and provision of security to guard power and other energy installations • S.3.3 of the Draft National Policy & Strategy for Radioactive Waste Management, 2017 prescribes that the government shall ensure that individuals, society, and the environment are protected from the harmful effects of ionizing radiation • S.3.11 prescribes that emergency response provisions to protect persons, property and the environment.	• Establish a disaster early warning and preparedness system • Rapid response to nuclear disasters and emergency • Public education and awareness on nuclear disasters • Mitigation strategies for radioactive environmental impacts	
Transboundary impacts • Transboundary public radioactive exposure	S3.1 of the National Nuclear Fuel Cycle Policy and Strategy, 2017 prescribes that: - • The ultimate responsibility for the safety of radioactive waste and spent fuel management shall rest with the national government through a waste management organization (WMO)		• Transboundary water related conflicts regarding international transfers – e.g. Nile Basin

Potential high-level impact	Proposed NuPEA mitigation strategies	SESA recommendations	Mitigation gaps
• Regional conflicts regarding accidental radiation exposure to migratory species – flamingos, Palearctic birds • Regional environmental conflicts regarding the radioactive contamination of shared transboundary heritage sites • Regional insecurity and terrorism • Transboundary water related conflicts regarding international transfers – e.g. Nile Basin • Transboundary water related conflicts regarding cross-border contaminations	• The nuclear regulator will regulate the safe management of radioactive waste. • S3.3 prescribes that the government shall ensure that adequate physical protection measures are taken to prevent unauthorized access to and/or unauthorized removal of radioactive waste/spent fuel • S.3.3 prescribes that the government shall ensure that individuals, society, and the environment are protected from the harmful effects of ionizing radiation • S3.3.1 prescribes the need to set up a Waste Management Organization in charge of receiving radioactive waste and spent fuel from the nuclear power plant, including long-term spent fuel management or disposal • S.3.6 prescribes that the government shall explicitly specify conditions on: (a) The export of radioactive waste/spent fuel; (b) The storage/disposal of radioactive waste/spent fuel on national territory after conditioning and/or reprocessing abroad; and (c) Seeking international /regional solutions to radioactive waste/spent fuel • S7.2 prescribes the need to initiate the early siting for geologic repositories of spent fuel early enough in the nuclear power programme • S8 prescribes the need to develop regulations on the requirements for nuclear fuel management • S10 & 11 prescribes the requirements for on-site and away-from reactor spent-fuel storage including appropriate containment of radionuclides • S6.1 of the Holistic Approach to Nuclear Safety, Security, and Safeguards (3S), 2015 recognizes that Kenya's nuclear power programme cannot be treated in isolation, owing to the potential transboundary effects of a radioactive release for which the necessary mitigation measures are required		

Source: SGS, 2019

8.3 Social and Economic Recommendations

Negative socio-economic outcomes of resource extraction are inevitable in the nuclear power sector. However, they can be tackled and mitigated through effective strategies, adoption of international social performance standards and best practices, review of legal frameworks and policies as discussed below: -

***a) Guidelines for Public consultation and information disclosure*:** This should be guided by international guidelines such as IAEA guidelines adopted from the Equator Principles' aligned International Finance Institutions (IFIs) such as the World Bank and IFC guidelines in areas of land acquisition, resettlement, compensation, SESA/EIA and Environmental Audit processes. The extent and level of information disclosure should be agreed upon to protect the government/ national interests, investors and community interests.

Early consultations and clear policy definitions on the roles of each of stakeholders in the NPP is of critical importance. This should be through various environmental and social planning and development tools and approaches like EIA, Environmental Audits and CSR or social investments programmes. Consultations on standards and practices of each of these stakeholders should generally be guided by IFC, EPs and other international standard guidelines and practices.

Engagement between investors, government, public, local leaders and employees should be continuous and undertaken at regular intervals to ensure smooth operation of activities and faster development of the sector. Transparency and responsiveness to requests for information and concerns from the local community and environmental civil society groups will be important to combat misinformation.

With inherent nature of Nuclear Power Programmes and attached public perception in Kenya (Mberia, 2014), NEMA and NuPEA should ensure investors demonstrate effective stakeholder engagement as an on-going process in a structured and culturally appropriate manner with affected communities and, where relevant, other stakeholders. For projects with potentially significant adverse impacts on affected communities, the investor should conduct an informed consultation and participation process as per the national and guidelines in stakeholder engagement.

It is recommended, that County Governments should be supported by the national government to develop guidelines and regulations on community engagement during the EIA process with interest to the socio-cultural and socio-economic background for all the 43 tribes in Kenya. These guidelines should be tailored to local traditional systems on community consultations and international best practices, especially those developed by IFC (*Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets*) (IFC, 2007). The proposed Community Stakeholder Engagement guidelines should be from community to community and for some special interest groups like women, youths, disabled, and indigenous communities etc.

The proposed guidelines should have general key components encompassing a range of activities and interactions over the life of every project. These can be divided into eight (8) key components: Stakeholder Identification/ Mapping and Analysis, Information Disclosure, Stakeholder Consultation, Negotiation and Partnerships, Grievance Management, Stakeholder Involvement in Project Monitoring, Reporting to Stakeholders, and Stakeholder Management Functions.

Based on the above IFC Handbook guidelines, companies should take a systematic (rather than ad-hoc) approach that is grounded in internal day-to-day business operations, create systems and internal capacities to track and manage stakeholder issues and risks more effectively. Implementation of this recommendation will make it easier for Nuclear Programme owners and contractors to get the Social Licence to Operate (SLO) which refers to the level of

acceptance or approval of the activities of an organization by its stakeholders, especially local impacted communities. It is recommended that the guidelines must provide guidance on Free, Prior and Informed Consent (FPIC) as a procedural mechanism developed to assist in ensuring the right of Indigenous peoples to self-determination without obstructing national development interests as enshrined in the Kenya constitution of 2010.
Public participation and stakeholder engagement being people centred should therefore be:

- Open and transparent
- Well communicated
- Informative and educative/ Provide enough information
- Inclusive and equitable
- Initiated early and sustained
- Well planned and focused on negotiable key issues
- Supportive to participants
- Respect local values, norms, culture/ religion
- Accountability to the community/ Feedback

b) Preparation of a Nuclear Sector Resettlement Policy Framework (RPF): Resettlement of Project Affected Persons will be required for the long-term investments and infrastructure, temporary use or as provision for way leaves, for example for power transmission lines and water pipelines. Systematic and step-by-step identification of project impacts and affected populations through mapping, census of project affected people (PAPs), inventory of affected assets, socioeconomic studies of PAPs, analysis of surveys and studies, consultation with affected people concerning assistance benefits and development opportunities should be undertaken.

Legal frameworks guiding compensation and relevant for the nuclear sector should be developed based on constitutional and land legal guidelines. The guidelines should take into consideration resettlement assistance and livelihood restoration; budget and implementation schedules; organisational responsibilities; consultation and participation procedures; grievance redress mechanisms; and monitoring and evaluation systems. In principle, the international IFC Environmental and Social Performance Standards and the World Bank Environmental and Social Standards (ES) on Resettlement Planning provide a yardstick for the national framework for the sector.
The MOE through NuPEA should prepare a Resettlement Policy Framework (RPF) for the nuclear sector to guide the selection and implementation of projects that will require precautionary measures related to involuntary resettlement. The RPF shall be complied with where involuntary resettlement, impacts on livelihoods, acquisition of land or restrictions to access natural resources and proceeds occur. The RPF should provide project stakeholders with procedures to address the risks that may arise from implementation of nuclear projects leading to economic and physical resettlement of populations. It should provide guidelines on how the projects should avoid, minimize, manage or mitigate and even compensate all project related displacement risk.

The RPF shall provide guidelines on preparation of resettlement plans of the affected people. As stated above, it should include a grievance redress mechanism to provide affected people with avenues for making a complaint or resolving dispute that may arise. Appropriate and mutually acceptable redress actions to be taken as well as providing a transparent and accountable implementation process.

There has been a problem with determination of eligibility, resource or asset valuation and restoration of livelihoods. NEMA in collaboration with National Lands Commission should take the lead in RAP approvals and implementation. This needs a legal framework to make approvals of RAP reports and implementation framework to be mandatory for projects before commencement to reduce social and economic impacts to Project Affected Persons (PAPs) as means to gaining a physical social license to operate.

The government should consider prioritization of more sustainable compensation models and better than the lump sum cash payments to PAPs who end up misusing it in a short period. The most sustainable methods to consider will be '*cash+land*' compensation and payment through instalments structured to cover longer periods depending on the lifespan of the projects. Of consideration also could be the adoption of land leasing model by the government instead of compulsory acquisition.

It is recommended that the Government should formulate a single legal framework that streamlines land acquisition for public investments and infrastructural projects. This will save the government from numerous hiccups emanating from land acquisition challenges and ownership conflicts. The projects are further delayed when land disputes end up in court where injunctions are imposed, blocking commencement of the projects even when contractors have moved to site, hired workers and procured perishable items like cement, and leased machinery that attract fees as they lay idle.

The government and the people of Kenya lose from such cases especially in the energy infrastructure development sector where daily idling costs are very high. There is need for preparation of a valuation roll, to enable all Kenyans know the market value of land across the country in order to end haphazard increase in land prices and speculation. Regular update of the land registry on way leaves to provide credible information on landowners is also recommended.

***c) Facilitate the implementation of local content plans*:** The MOE should develop a policy framework on how to work with the National Cohesion and Integration Commission (NCIC) in implementation of local content strategy and plans in order to limit conflicts especially during the implementation of national projects sectors at the county level, especially when more than one county/ community is involved.

The NCIC is a statutory body established under the National Cohesion and Integration Act (Act No.12 of 2008) and its mandate is to facilitate and promote equality of opportunity, good relations, harmony and peaceful coexistence between persons of different ethnic and racial communities of Kenya and to advise the Government on all aspects thereof. This must be accompanied with cohesion and integration education to the local communities and all Kenyans in general.

d) Development of Guidelines for access to land for the NPP: There is need for clear guidelines on how companies and the government should acquire land to be used for NPP. Kenya has many tenure systems which are not clearly separable, which sometimes leads to communities losing their land. This report has already discussed the best practices in land compensation; but this should not occur in isolation. Communities must be fully informed of their land rights and given a chance to participate in the negotiation process. Plans and policies must also ensure the conservation of land and its resources during and after the project. Guidelines for land access to indigenous communities, whose land tenure system is usually communal, should be specially tailored to mitigate them from socio-economic resettlement impacts with the guidance of the Community Land Act, 2015. In areas of communal ownership, such as the Tana Delta within the Tana River Basin, are very immotile and have a potential to derail a project.

e) Develop monitoring programmes to ensure application of human rights: In Development pf legal structures for the Nuclear Power. The following recommendations need to be considered: -

- Be informed prior to carrying out of Nuclear Power operations within their county and sub-county.

- Put forward any inquiries, interrogate planned activities which directly or indirectly affect their interaction with the ecosystem during the preliminary phase of awarding of permits for consideration;
- Adequate compensation for land taken over for nuclear power operations in accordance with relevant land laws and the constitution;
- Be compensated by any contractor who causes environmental damage and/or pollution;
- Be compensated for any injury and/or illness directly or indirectly related to the nuclear power operations if the contractor was in a position to take measures to prevent the occurrence of the same;
- Compensation for damage to property and lost source of revenue or livelihood as a result of Nuclear Power operations taking place in their immediate surroundings;
- Be educated and sensitized on Nuclear Power operations within their county and sub-county; and
- Participate in planning for Corporate Social Responsibility (CSR) projects that are to be implemented within the community by the contractor and PPP owner.

Monitoring programmes to ensure the application of the international principle of Free, Prior and Informed Consent (FPIC) in NPP development should be instituted by the MOE through support of other partners.

A human rights-based approach refers to a conceptual and procedural framework directed towards ensuring the promotion and protection of human rights in policies, programmes, plans and projects. It is the basis of all human rights relevant instruments and actions and has been applied in a wide range of contexts (notably in health and development cooperation). It seeks to: (1) position human rights and its principles as the core element of actions; (2) demand accountability and transparency by duty-bearers towards rights-holders; (3) foster empowerment and capacity building of rights-holders to, inter alia, hold duty-bearers to account; (4) ensure that the meaningful participation of rights-holders in development processes and planned interventions is recognised as an intrinsic right, not simply as best practice; and (5) ensure the non-discriminatory engagement of rights-holders and the prioritization of especially-vulnerable or marginalized individuals or groups (e.g. women, elderly, children and youth, minorities and Indigenous peoples).

f) Mainstreaming Gender Issues and Vulnerability in the Nuclear Sector: Kenya is a signatory to various international and regional protocols such as the Convention for the Elimination of Discrimination against Women (CEDAW) and the Africa Protocol on Women's Rights. Due nuclear power activities in Kenya, a number of legal and institutional frameworks have been developed for the exploration, production and management of the industry, but there is no clear demonstration or commitment to gender responsiveness in these legal and institutional considerations. Often, men have better access to benefits via employment and supplies, while the costs such as family/social disruption fall most heavily on women.

The Kenyan constitution provides fundamental policy guidelines to protect male and female citizens from gender imbalance. Gender imbalance experienced elsewhere on the African continent has exacerbated inequality. It has resulted in costly social conflicts and entrenchment of poverty in oil producing areas and widened gaps between the rich and the poor, who are mostly women, children and the youth.

These historical lessons from some African countries, in implementation of mega projects, should serve as guidelines to strengthen citizen participation, including women's rights and gender-oriented organizations in policy dialogues in the sector. Strong citizens' participation will contribute to better management of the industry and ensure livelihood diversification and sustainability.

Access to jobs and opportunities should be enhanced for all gender groups, people living with disabilities, marginalised, and minority communities. The MOE should undertake a study on how to mainstream gender issues in nuclear policies in order to ensure ample regulation to address gender issues in the growing nuclear sector. This must also be extended to the proposed local content strategy.

There should be commitment to the implementation of gender provisions in the Kenya Constitution and legal provisions in the National Gender Equality Commission (NGEC) Act (Cap. 15) of 2011. The objective of this recommendation is to promote gender equality, and social responsiveness and freedom from discrimination in the nuclear sector.

g) Preparation and implementation of the Vulnerable and Marginalized Groups Framework (VMGF): as part of proposed gender study, the MOE should develop the VMGF as one of its outputs. The objective of the VMGF is to ensure the development process associated with nuclear fully respects the dignity, human rights, economies and culture of vulnerable and marginalized people and the sector projects have broad community support from the affected vulnerable and marginalized people.

The VMGF should recognize that this support can only be attained through free, prior and informed consultation. To that end, the VMGF should provide guidelines which will avert any potentially adverse effects on the vulnerable and marginalized groups; or if avoidance proves not feasible, minimize, mitigate or compensate for such negative impacts. The VGMF should also ensure vulnerable and marginalized groups receive social and economic benefits that are culturally appropriate and inclusive in both gender and intergeneration terms.

h) Development of a National Communication Strategy for the Nuclear Sector and implementation of a Public Education Awareness Programme: The MOE through the implementing agency, NuPEA should develop and implement a communication strategy on the process and timelines associated with NPP sector to manage expectations and perceptions of local communities/leaders and Kenyan people in general as found out by Mberia, 2014.

Local communities usually have high expectations on benefits to be accrued through mega infrastructural developments. Majority expect employment, opportunities for supply of goods and services failure to which, they decline to support harnessing of resources for NPP development as well hindering the process itself leading to project delays. This necessitates a communication strategy to disseminate factual information to the communities to manage their expectations as well enhance positive perceptions. This will also ensure that the nuclear sector development coexists with the traditional economic.

There is also need for government to manage expectations of local communities and their leaders and invest in communication about the process and timelines associated with NPP. Implementation of a public communication strategy, along with transparency will be the primary tools for controlling misinformation by explaining the importance of NPP for the Kenyan people, especially those in rural areas, and safety attached. This strategy will also be a key tool in achieving local community 'buy-in' (social licence). GoK should ensure transparency and access to information regarding its vision, strategies, decision-making processes, revenue realisation and utilisation, and development priorities.

Basic information on the outlook of the sector needs to be clear and accessible, for example, how many and what type of job/business opportunities will be created over the next year and beyond, and what are the factors that would alter this/ put this at risk.

The communication strategy should also cover national awareness programmes to reduce the adverse impacts associated with nuclear developments, emergency response and disaster management strategies. This should be integrated to the school/ college curriculum for sustainability purposes. All forms of communication channels including but not limited to community/ village/ county forums, print, digital and social media should be targeted.

i) Promotion of Community Development Programmes: The nuclear development multi-national companies should work closely with local administration, community leaders, civil society organisations and National and County governments to initiate short, medium and long-term interventions that can improve the communities' socio - economic well-being. The Government of Kenya should develop a mechanism to facilitate such engagement. This in effect will make the host communities identify with and appreciate the exploration and production projects and 'own' them, thus leading to 'social licence', increased prosperity and participation in critical initiatives.

***j) Development and Enhancement of GoK security strategy/ master plan of the nuclear sector*:** GoK needs to enhance its security strategy to ensure adequate security personnel; modern technology and equipment, ICT and financial resources are assigned NPP installations for sustainability of the nuclear power sector. This should cover all major reactors, fuel processing plants, radioactive waste storage / disposal plants, and transport systems. The GoK should improve the ability of Kenya's Defence Forces, National Intelligence Service, and National Police Service to protect critical infrastructure in the nuclear sector by having institutional units covering security measures and issues that would foster information sharing. The risk of cyber-attacks, terrorist attacks and proliferation associated with nuclear power programmes, necessitates a strong security system encompassing well trained human personnel and strong system firewalls against hacking.

Relevant guising International Legal Structures in development of strategies and legislation to ensure nuclear security include: -

- Convention on the Physical Protection of Nuclear Material and 2005 (Amendment)
- International Convention for the Suppression of Acts of Nuclear Terrorism (Nuclear Terrorism Convention).
- Comprehensive Safeguards Agreement and Additional Protocol that is also relevant for security.
- Code of Conduct on Safety and Security of Radioactive Sources.

The IAEA Nuclear Security Series contains guidance documents that can assist Kenya in developing its security infrastructure. Those particularly relevant for a nuclear power programme include:

- IAEA Nuclear Security Series No. 4: Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage, (IAEA, 2007);
- IAEA Nuclear Security Series No. 8: Preventive and Protective Measures Against Insider Threats, (IAEA, 2008); and
- IAEA Nuclear Security Series No. 14: Nuclear Security Recommendations on Radioactive Material and Associated Material, (IAEA, 2011);

k) Setting up of a Nuclear Training Fund: The responsibility of operating the nuclear training fund is vested in the Cabinet Secretary in charge of the nuclear sector. There is need for more detailed policy and legal mechanisms to guide the operation of the fund. The amounts contributed should be a percentage of the licence fee and accrued revenues thereafter in order to strengthen programmes of human capital development among Kenyans. All the training funds should be channelled to relevant government institutions to support capacity building programmes though academic and development research and technical innovations.

There is need to harmonize all the training programmes and needs assessments in the private and public sector to ensure quality standards through a curriculum accreditation process. This could be managed through a partnership with the Commission for University Education, The Technical and Vocational Education and Training Authority (TVETA) and with input from existing private institutions, and middle-level institutions of learning and Universities (private and public).

Nuclear sector being a new industry in the country, it should be appreciated that not only NEMA needs capacity building on it. All lead agencies require institutional capacity building to handle the new challenges. Full grasp of environmental and social issues and the capacity to effectively supervise, control and measure potential environmental and social effects will enable NEMA to put in place efficient nuclear sector governance system. No less important is that the benefits of an extensive training programme will also positively extend to other sectors of Kenyan institutions and civil society that are not necessarily linked to nuclear industry development. Besides there is need of setting the appropriate training objectives and the identification of major technical and organizational gaps within the institutions involved.

l) Equitable Distribution and Allocation of Revenue and other Benefits from the Nuclear Sector: First, there is need to map the energy sector to be in line with the responsibilities of both the central and county governments as enshrined in the new constitution. There is also the need to address any conflict that may arise between laws especially on revenue sharing formulas and with other relevant legislative pieces and the revenue sharing responsibility as given in the Commission for Revenue Allocation Act and any other bill/Act on revenue sharing. A comprehensive Local Content Act needs to be passed to ensure boundaries are well defined with regards to employment and resource distribution in counties. Acceptable definition of who the local community consists of will also help in prevention of conflict that may arise as a result of revenue distribution because economic costs and benefits resulting from this resource cuts across borders and communities/ clans in the candidate areas or NPP footprint areas.

m) Development of Population migrations/ influx management plans by Ministry of Health/ County Government Health Departments in candidate areas and health issues: These plans will address unfair/unequal competition for opportunities between immigrants and local populations and can be done through policy enforcement on fair competition and affirmative action. IFC's handbook for addressing Project-Induced immigration: Projects and People (IFC, 2009) gives insight and direction on how to lay strategies to address this.

n) Development and Implementation of Local Content Strategy*:* It is recommended that the sector stakeholders within the country should seek to maximise the benefits of nuclear wealth generation through a comprehensive strategy that includes: -

- The use of local expertise, goods and services, labour (including skilled and semi-skilled) and financing in the NPP activities. Efforts to encourage local value addition on a no-subsidy basis should also be encouraged.
- Develop local capability in the nuclear value chain through education, technical skills and relevant expertise development, transfer of technology and know-how, and active research and development.
- Target an agreed level of local participation and investment in all aspects of the nuclear industry value chain. GoK and all stakeholders should work to enhance the participation of the local private sector, civil society, academia, local communities, women's organisations, and other affected groups in the decision-making processes to ensure effective governance of the sector. The National Government should design and implement a framework for working with the private sector to achieve local content regulations and integrate their corporate social responsibility/ social investment objectives with Kenya's national and county development plans.

8.4 Occupational Safety and Health Recommendations

8.4.1 Global advancements towards in Nuclear Safety

The radiation risks to workers, the public and the environment that may arise from its applications are necessary to be assessed and controlled. Therefore, the operation of nuclear installations, the production, transport and use of radioactive material and the management of radioactive waste must be subjected to safety standards. The prime responsibility for safety must rest with the person or organization responsible for these activities. Regulating safety is a national responsibility in the area of operation. However, radiation risks may transcend national borders, and international cooperation serves to promote and enhance safety globally by exchanging experience, and by improving capabilities to control hazards, to prevent accidents, to respond to emergencies and to mitigate any harmful consequences. The IAEA is required by its Statute to promote international cooperation.

8.4.2 The IAEA Safety Standards

The IAEA safety standards provide a robust framework of fundamental principles, requirements and recommendations to ensure safety. They are developed through an open and transparent process for gathering, integrating and sharing the knowledge and experience gained from the use of technologies and from the application of the safety standards, including emerging trends and issues of regulatory importance. They contribute to the establishment of a harmonized high level of safety worldwide by serving as the global reference for protecting people and the environment and development of national legal and regulatory framework on safety of nuclear operations.

The objectives of these standards are: -

(a) To control the radiation exposure of people and the release of radioactive material to the environment.
(b) To restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation; and
(c) To mitigate the consequences of such events if they were to occur.

Table 8-3: General provision of International Nuclear Safety Standards

Table 8-3: General provision of International Nuclear Safety Standards

No.	Principle	Definition	General guidelines/ standards / Roles
1	Responsibility for safety	The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.	• The organization responsible for any facility or activity that gives rise to radiation risks or for carrying out a programme of actions to reduce radiation exposure has the prime responsibility for safety. • Authorization to operate a facility or conduct an activity may be granted to an operating organization or to an individual, known as the licensee. • The licensee retains the prime responsibility for safety throughout the lifetime of facilities and activities, and this responsibility cannot be delegated. • The licensee is responsible for: ✓ Establishing and maintaining the necessary competences; ✓ Providing adequate training and information; ✓ Establishing procedures and arrangements to maintain safety under all conditions; ✓ Verifying appropriate design and the adequate quality of facilities and activities and of their associated equipment; ✓ Ensuring the safe control of all radioactive material that is used, produced, stored or transported; ✓ Ensuring the safe control of all radioactive waste that is generated
2	Role of government	An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained.	• Establishment of a legal and governmental framework that provides for the regulation of facilities and activities that give rise to radiation risks and for the clear assignment of responsibilities. • Preparing programmes of actions to reduce radiation risks, including actions in emergencies, for monitoring releases of radioactive substances to the environment and for disposing of radioactive waste. • Establishment of a regulatory body with key clear-cut mandate not overlapping with other agencies. • The regulatory body should: ✓ Have adequate legal authority, technical and managerial competence, and human and financial resources to fulfil its responsibilities; ✓ Be effectively independent of the licensee and of any other body, so that it is free from any undue pressure from interested parties; ✓ Set up appropriate means of informing parties in the vicinity, the public and other interested parties, and the information media about the safety aspects (including health and environmental aspects) of facilities and activities and about regulatory processes; ✓ Consult parties in the vicinity, the public and other interested parties, as appropriate, in an open and inclusive process.

No.	Principle	Definition	General guidelines/ standards / Roles
			✓ Establish standards and regulatory framework for protecting people and the environment against radiation risks
3	Leadership and management for safety	Effective leadership and management for safety must be established and sustained in organizations concerned with facilities and activities that give rise to, radiation risks.	• Leadership in safety matters has to be demonstrated at the highest levels in an organization. Safety has to be achieved and maintained by means of an effective integrated management system. The management system also has to ensure the promotion of a safety culture, the regular assessment of safety performance and the application of lessons learned from experience. • The culture should demonstrate: - ✓ Individual and collective commitment to safety on the part of the leadership, the management and personnel at all levels; ✓ Accountability of organizations and of individuals at all levels for safety; ✓ Measures to encourage a questioning and learning attitude and to discourage complacency with regard to safety • The precursors to accidents have to be identified and analysed, and measures have to be taken to prevent the recurrence of accidents, full with feedback mechanisms.
4	Justification of facilities and activities	Facilities and activities that give rise to radiation risks must yield an overall benefit	• For facilities and activities to be considered justified, the benefits that they yield must outweigh the radiation risks to which they give rise. • For the purposes of assessing benefit and risk, all significant consequences of the operation of facilities and the conduct of activities have to be taken into account. • In many cases, decisions relating to benefit and risk are taken at the highest levels of government, such as a decision by a State to embark on a nuclear power programme. • In other cases, the regulatory body may determine whether proposed facilities and activities are justified
5	Optimization of protection	Protection must be optimized to provide the highest level of safety that can reasonably be achieved.	• The safety measures that are applied to facilities and activities that give rise to radiation risks are considered optimized if they provide the highest level of safety that can reasonably be achieved throughout the lifetime of the facility or activity, without unduly limiting its utilization. • To determine whether radiation risks are as low as reasonably achievable, all such risks, whether arising from normal operations or from abnormal or accident conditions, must be assessed (using a graded approach) and periodically reassessed throughout the lifetime of facilities and activities. • The optimization of protection requires judgements to be made about the relative significance of various factors, including: ✓ The number of people (workers and the public) who may be exposed to radiation;

No.	Principle	Definition	General guidelines/ standards / Roles
			✓ The likelihood of their incurring exposures; ✓ The magnitude and distribution of radiation doses received; ✓ Radiation risks arising from foreseeable events; ✓ Economic, social and environmental factors.
6	Limitation of risks to individuals	Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.	• Justification and optimization of protection do not in themselves guarantee that no individual bears an unacceptable risk of harm. Consequently, doses and radiation risks must be controlled within specified limits. • Optimization of protection and the limitation of doses and risks to individuals are necessary to achieve the desired level of safety
7	Protection of present and future generations	People and the environment, present and future, must be protected against radiation risks	• The possible consequences, now and in the future, of current actions have to be taken into account in judging the adequacy of measures to control radiation risks. In particular: ✓ Safety standards apply not only to local populations but also to populations remote from facilities and activities. ✓ Where effects could span generations, subsequent generations have to be adequately protected without any need for them to take significant protective actions. • Radioactive waste must be managed in such a way as to avoid imposing an undue burden on future generations; that is, the generations that produce the waste have to seek and apply safe, practicable and environmentally acceptable solutions for its long term management. The generation of radioactive waste must be kept to the minimum practicable level by means of appropriate design measures and procedures, such as the recycling and reuse of material.
8	Prevention of accidents	All practical efforts must be made to prevent and mitigate nuclear or radiation accidents.	• The most harmful consequences arising from facilities and activities have come from the loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or other source of radiation. Consequently, to ensure that the likelihood of an accident having harmful consequences is extremely low, measures have to be taken: ✓ To prevent the occurrence of failures or abnormal conditions (including breaches of security) that could lead to such a loss of control; ✓ To prevent the escalation of any such failures or abnormal conditions that do occur; ✓ To prevent the loss of, or the loss of control over, a radioactive source or other source of radiation. • The primary means of preventing and mitigating the consequences of accidents is 'defence in depth' by: - ✓ An effective management system with a strong management commitment to safety and a strong safety culture. ✓ Adequate site selection and the incorporation of good design and engineering features providing safety margins, diversity and redundancy, mainly by the use of: Design,

No.	Principle	Definition	General guidelines/ standards / Roles
			technology and materials of high quality and reliability; Control, limiting and protection systems and surveillance features; and an appropriate combination of inherent and engineered safety features ✓ Comprehensive operational procedures and practices as well as accident management procedures. • Accident management procedures must be developed in advance to provide the means for regaining control over a nuclear reactor core, nuclear chain reaction or other source of radiation in the event of a loss of control and for mitigating any harmful consequences
9	Emergency preparedness and response	Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents	• The primary goals of preparedness and response for a nuclear or radiation emergency are: ✓ To ensure that arrangements are in place for an effective response at the scene and, as appropriate, at the local, regional, national and international levels, to a nuclear or radiation emergency; ✓ To ensure that, for reasonably foreseeable incidents, radiation risks would be minor; ✓ For any incidents that do occur, to take practical measures to mitigate any consequences for human life and health and the environment. • Scope and extent of arrangements for emergency preparedness and response have to reflect: The likelihood and the possible consequences of a nuclear or radiation emergency; The characteristics of the radiation risks; and the nature and location of the facilities and activities. • In developing the emergency response arrangements, consideration has to be given to all reasonably foreseeable events. Emergency plans have to be exercised periodically to ensure the preparedness of the organizations having responsibilities in emergency response.
10	Protective actions to reduce existing or unregulated radiation risks	Protective actions to reduce existing or unregulated radiation risks must be justified and optimized	• Radiation risks may arise in situations other than in facilities and activities that are in compliance with regulatory control. In such situations, if the radiation risks are relatively high, consideration has to be given to whether protective actions can reasonably be taken to reduce radiation exposures and to remediate adverse conditions. ✓ One type of situation concerns radiation of essentially natural origin. Such situations include exposure to radon gas in dwellings and workplaces, for example, for which remedial actions can be taken if necessary. ✓ A second type of situation concerns exposure that arises from human activities conducted in the past that were never subjected to regulatory control, or that were subjected to an earlier, less rigorous regime of control. An example is situations in which radioactive residues remain from former mining operations. ✓ A third type of situation concerns protective actions, such as remediation measures, taken following an uncontrolled release of radionuclides to the environment.

No.	Principle	Definition	General guidelines/ standards / Roles
			• The protective actions are considered justified only if they yield sufficient benefit to outweigh the radiation risks and other detriments associated with taking them.

Source: (IAEA, 2011) (No. SSR-2/2)

8.4.3 Conventions

A number convention as identified in section 7.2 (b) have been developed as international legal structures on nuclear safety but Kenya is not party to them.

8.4.4 Codes of Conduct

- Code of Conduct on the Safety and Security of Radioactive Sources, through its implementation will help national authorities ensure that radioactive sources are used within an appropriate framework of radiation safety and security
- Code of Conduct on the Safety of Research Reactors strengthens the international nuclear safety arrangements for civil research reactors, taking due account of input from the International Safety Advisory Group (INSAG) and the views of other relevant bodies.

It would be prudent, in the spirit on conventions, to ratify the international legal structures, domesticate their provisions into the local legal context in planning and implementation of the NPP.

8.4.5 General Recommendations

There are many occupational safety and health issues that need to be overcome in the areas of awareness, education, training, corporate commitment and compliance. These challenges can be overcome by employing a combination of appropriate proactive as well as reactive strategies. With reference to the issues raised in the stakeholders' meetings, the following strategic recommendations are feasible;

- There should be a clear set of guidelines and regulations provided with regards to safe distances/buffer zones for developing NPP facilities. Safe distances should be provided with reference to risk assessment, ensuring 100% safety of persons/organisms who do not directly interact within the NPP development. KEBS should set up an independent task force to harmonize all HSE standards of the local nuclear sector.
- A standard impact assessment study should involve risk assessment. It is evident that EIAs have been approved without a complement of risk assessment. A very good example is EIAs for road infrastructure where multi-criteria decision analysis should be used to assess the sustainable safety performance of road projects at the design stage. This criterion ought to be used in all projects undergoing EIA. There is also need to develop a Multi Criteria Decision Analysis framework for risk management of the nuclear power sector in Kenya.
- Development of policy guidelines in the relevant codes of practice for OSH Auditing and OSH Performance Monitoring in the nuclear sector. Issues of training, PPE and quality controls on workplace hazards should be properly instituted to allow full compliance or consequences for non-compliance.
- Harmonization of duplicated roles performed by NEMA, DOSH, ERC, and KEBS in administering of EHS issues in the energy sector. The lead agencies can conduct joint inspections, investigations, enforcement and monitoring of NPP facilities in compliance with the accepted risk management plan and with the broader legislative framework. Inspections to be carried out using a risk-based methodology that considers relevant risk factors, performance and compliance history, current industry incident trends, and any relevant findings from previous inspections. Upon completion of an inspection, the authority's inspectors should issue the company a detailed report of the inspections findings, conclusions and any recommendations for improvement. If necessary, inspectors may also request a company to provide them with their proposed actions to address issues highlighted in the inspection report.

- There is need to enhance the DOSHS human resource and technical capacity. Hiring more inspectors to manage remote areas in particular for sustainable and equitable enforcement of OHS laws and regulations in all the 47 counties and sub-counties.
- Enhancing public awareness and encourage their participation in monitoring EHS activities of the nuclear sector. Enlightening them on roles they have to play in ensuring their own safety through EHS advocacy programmes. Media used to disseminate information can be achieved through; seminars held on communal or public spaces, learning and religious institutions. Promoting EHS awareness on nuclear power based risks through media houses such as television, radio stations (for English, Swahili and Vernacular).
- Radioactive waste vehicle drivers should be trained and educated on safe transportation and handling of such dangerous waste. There is need to formulate clear guidelines for training the drivers so as to ensure competence as well as safety of the public at large due to risks accompanied by duties executed by them. The drivers should also undergo a specific training induction. The Industry Training Standard to cover all the knowledge and skills that such a driver should have to perform the job to a high and consistent standard. Annual refresher training may not be required as drivers should already have the required knowledge, but immediate practical assessment may be necessary in these instances. The training for these drivers should include key aspects like firefighting and first aid administration.
- Formulation and Implementation of the National Disaster Risk Reduction and Emergency Response Management Plan: Develop adequate disaster management structures through formulation of plans and policies that will provide sufficient guide to the relevant authorities who implement and enforce. Emergency service provisions should be in place for response and assistance in the occurrence of accidental spills and fires. The disruption caused by disasters can be prevented and minimized by putting mitigation structures in place mainly through enhancing government responsibilities as follows;
    - Establishing a framework for managing disasters in Kenya that takes into account the difference between rapid onset and slow onset disasters.
    - Building the capacity of institutions to act appropriately in the face of disasters.
    - Building a well-managed disaster response system.
    - Ensure that disaster policy intersect with development policy and poverty-reduction. It must be multi-sectoral and applicable at all levels.
    - Ensure that disaster management is coordinated and focuses on both risk reduction and maintaining an efficient disaster response capacity.
    - Promoting linkages between disaster management and development.
    - Promoting programmes and strategies that aim to reduce the vulnerability of Kenyans to the recurrent hazards they face, preparing communities at all levels by strengthening their capacities, preparedness and resilience.
    - Providing clear financial provisions for disaster management.
    - Providing adequate and sufficient resources to ensure the effective implementation of the policy and subsequent strategies and programmes.
    - Promoting disaster management training and community awareness.
    - Integrating Disaster Risk Reduction and Disaster Management into National development planning at all levels.
    - Integrating Environmental Safety and Health and Disaster Management into National Education Curriculum, so as to become part of National Education System. This would aid in mitigating health and safety risks in the nuclear sector.
    - Systematically monitoring and evaluating the trends and status of climate change and its impacts on the various types of disasters and development issues.
    - Counties to develop their responsive disaster management plans using national frameworks.

- NEMA in conjunction and consultation with other likeminded agencies/ authorities to provide clear and sustainable guidelines on radioactive waste/ spent fuel/ radioactive emissions management with reference to the best available and safest practices.
- Enhance EHS technical capacity in radioactive waste in NPP developments through specific trainings tailored towards enhancing treatment and emissions management skills.
- Adopting international standards and reviewing our own local regulations to enhance our capacity to protect the environment and natural resources from negative impacts associated with the industry.

8.4.6 Specific EHS recommendations

a) Develop Guidelines for Health and Safety Audit NPP Activities: Undertaking of regular Environmental, Health and Safety audit of all NPP facilities in the country to determine how radioactive wastes and nuclear spent fuel were managed, environmental quality (water, air, soil, animal, and vegetation), status and health of the local communities, violations of international best practices and laws, any human rights violations and any positive or negative impacts to local communities. The study should find out lessons to learn for future NPP activities, environmental management plan and health innovations required. Companies involved NPP operation should prepare standard quarterly Sustainability Reports to support the audit and monitoring process for submission to NEMA. The reports should contain common EHS metrics that are designed to ensure that the companies are accountable to their EHS policies.

a) ***Carry out Health and Safety Audit of spent fuel and radioactive waste transportation modes:*** There is need for independent, comprehensive and mandatory Environmental, Health and Safety audits of nuclear transport infrastructure to identify risk areas. The study should also find out the level of public awareness on risk associated with storage and transportation of nuclear spent fuel and radioactive waste. The audits should develop budgets for implementation of findings by various agencies like KENHA, KURA, KRC, and other relevant government agencies. Part of the audit is to regularly analyse security situation along the transport infrastructure. The agencies must allocate financial and human resources to implement the findings from annual audit reports.

b) ***Mainstreaming International Legal provisions into the local legislation on Occupational Health and Safety***: The Ministry of Energy should ensure mainstreaming of provisions of the following conventions into the OSHA 2007 and EMCA, Cap 387

i. Convention on Nuclear Safety: Ensure the following provisions are integrated: - development/ amendment of national legislative and regulatory framework to establish a system of licensing of nuclear installation; establish a regulatory body to implement legislative and regulatory framework; effectively separate the regulatory body from NPP implementing agencies; assign clear responsibilities to licensees among other provisions set out in the convention.
   Under this, we recommend that the mandate of KNRA be expanded through an Act of Parliament on either Nuclear Safety Act/ Radiation Protection Act, to a Nuclear Safety Authority.
ii. Joint Convention on the Safety of Spent Fuel Management and Radioactive Waste Management: Ensure the following provisions are incorporated: - safety requirements of spent fuel management; siting of proposed facilities; assessment of safety facilities; disposal of spent fuel; safety requirement of radioactive waste management; relevant legislative framework formulation; and transboundary considerations among others
iii. Convention on early notification of a nuclear accident
iv. Convention on assistance in case of a nuclear accident or radiological emergency

c) ***Development radiation protection standards: -*** With reference to International Commission on Radiological Protection, the country through the DOSHS, KNRA and KEBs should develop national radiation protection standards. Another important reference is the Basic Safety Standards for protection Against Ionizing Radiation and for the Safety of Radiation Sources issued by IAEA in cooperation with FAO, ILO, OECD/NEA, PAHO and WHO (IAEA Safety series, No 115) (IAEA, 1996).

d) ***Development of an East Africa regional nuclear policy under East Africa Community:*** Policy concerns with neighbouring countries within a region are of increasing importance. This is vital for nuclear power programmes as there are many areas/ issues of regional cooperation such as: -

- Electric grid integration
- Nuclear safety
- Environmental protection
- Sharing of nuclear plant services
- General R&D and human resources development
- Nuclear fuel cycle
- Non-proliferation measures

8.5 Recommendations on development of typical nuclear power infrastructure considerations

Physical facilities needed for effective implementation of the nuclear power plant are to be established in compliance with the codes, standards and regulations or by using the best engineering and organizational practices. Prior to the awarding of the construction permit and during the construction and commissioning, the authorities must review and approve the plans set up by the project sponsor to establish these facilities. All the listed support infrastructure has to be aligned to the OSHA 2007 and other stringent relevant international standards and guidelines as relevant nuclear safety conventions, the IAEA safety standards and the World bank/IFC EHS general guidelines. The facilities include: -

a) Site infrastructure: The most important element of infrastructure is the existence of a site with acceptable characteristics such as appropriate geological and seismic conditions, access to adequate cooling water, proper location on the grid, etc. The selected site will have its own infrastructure features and facilities as described below:

- ***Water supply:*** Sources of water for construction phase and for cooling and other services during operation of the plant should be acceptable from quantity and quality points of view.
- ***Power supply***: Power supply during construction and operation will be provided through the national grid and supplemented by standby and emergency power supply systems. Substations will be needed to provide the required voltages during the construction and operation phases of the plant.
- **Transport/Access:** It is necessary to survey the access roads and railways to the site in order to determine if the width of the roads, radius of the bends and the clearance under bridges and in tunnels are adequate for the heaviest, widest, longest and tallest pieces of equipment which have to be delivered by road. If the candidate site is to be located on large rivers and sea shores, construction of a harbour capable of receiving and handling very heavy loads is needed to utilize delivery of large equipment by water.
- ***Micro earthquake monitoring station***: The seismic hazard study will determine the maximum ground motion parameters under the largest potential earthquake with sufficiently low probability of occurrence for the site. In order to verify the methodology and conclusions of the seismic hazard study, a number of micro earthquake monitoring stations have to be set up the region of the site for several years in advance of construction to provide data on rock characteristics and attenuation laws.

- ***Meteorological and hydrological station***: Site investigation studies require significant meteorological and hydrological data including maximum, basic and mean values for air and sea water temperatures, wind speed and direction, atmospheric pressure, dispersion patterns rainfall, ground water and surface flooding, wave action and tsunamis. Stations for collection and monitoring of this data are required to be put in place for a number of years prior to the approval of the site.
- ***Town site and administration facilities:*** Pre project and project management activities require working space and in remote sites, town site for living accommodations of the workers. This could be set up by the authorities in advance, or could be contracted as part of the project supply contracts.

b) Grid infrastructure: The interaction between the grid and the nuclear power plant is impacted by several factors including: Size of the plant output compared to the grid size, Location of the plant on the grid, and Reliability of the grid interconnects. The commercially available reactors are mostly of large size, and may have economic impact as a result of the need for additional spinning reserve, transmission lines, and interconnect equipment which may be required to strengthen the grid for accepting the large output of a single nuclear unit. The grid should also have the capability of providing the plant with external power supply which is independent of the plant output.

c) Physical protection facilities: The security of the nuclear facilities is an important criterion for site selection and for establishing plant configuration and plant operational procedures. Plant security is ensured primarily through features that are built into the strength of the structures, configuration of the systems and layout of the buildings, and barriers and security systems which are set up to restrict access and entry into the plant. The final security measure is through the regional and national security agencies that monitor the potential sources of threats against the critical facilities such as nuclear power plants and devise and implement plans and procedures to counter them.

d) Standard calibration laboratory facilities: The safe construction and operation of the nuclear power plants requires devices for the reliable measurement of various nuclear, thermal, hydraulic and mechanical parameters needed to determine the operating status of the plant at any time. These devices are calibrated during the commissioning process and are tested and recalibrated periodically thereafter.

e) Storage/Disposal of low and medium radioactive waste: Low and intermediate radioactive waste are to be stored by minimizing the space required and in a manner that will allow an easy transfer to disposal sites in the future. The safe storage of this material will provide sufficient time for the utility and the government to select and apply the most appropriate disposal approach and technology. National laws and specific agreements with the government, which are independent of changes to the owners and operator of the plant, should ensure operational stability and safety of the waste management facilities.

f) Spent fuel storage and disposal facilities: In many nuclear plants, the management of spent fuel is carried out in three stages. In the first stage, the fuel is stored in pools of water, which are part of the power plant, in order to be cooled off before reprocessing or for transfer to interim storage facilities. In the second stage the spent fuel is either shipped and reprocessed in central facilities (to extract its fissile material for reuse as fuel) or is stored in interim storage facilities within the plant exclusion zone and which are often designed for over 100 years of operational life. The final stage is the permanent disposal of the spent fuel in deep geological formations, which is currently being developed by several countries. The reliability of the interim storage concept provides sufficient time and confidence in the timely commercial deployment of disposal facilities.

g) Safeguards plan and equipment: The purpose of safeguards is to ensure that special fissionable and other nuclear materials, services, equipment, facilities, and information are not utilized for purposes other than for the peaceful application of nuclear energy. To implement the safeguard, a state system of accounting for and control of nuclear materials must be established in the country in order to coordinate the agencies in possession of nuclear material and for interface with IAEA safeguard inspectors. Adequate physical protection of the plant and of any nuclear material is a combined utility and national responsibility.

h) Emergency response facilities/ Emergency response organization: Concern for potential accidents underlines the importance of the establishment, by the regulatory authority, of requirements for the plans and procedures for coping with their impacts on the plant operators and the general population. In preparation for an unlikely event of a nuclear incident, the plant operator's emergency plans and procedures should ensure that all issues of concern are planned for and are covered.

h) Emergency notification of nuclear incidents: The preparation of plans and procedures to cover emergency situations transcending the power plant's limits is also essential and involves local and national organizations and authorities in addition to the utility and the regulatory body. According to the international convention on early notification, all relevant information should be made available to all countries with potential impact from the emergency.

i) Communication: Implementation of an advanced computer based information management system capable of exchanging, controlling, and archiving all correspondences and publications of the project is needed at the start of the project. Through the use of high speed internet connections, the various sites with project related activities should be in contact at all times. In remote site locations where there may not be access to the national network of high speed data links a special satellite communication station should be set up for the project to link the project management team at the site to the suppliers' home offices, nuclear regulatory headquarters and other regulatory and licensing authorities.

j) **A preoperational program** should be conducted in the environs of the proposed nuclear power plant site to:

- Measure background levels and their variations in environmental media in the area surrounding the plant,
- Evaluate procedures, equipment, and techniques, and
- Provide experience to personnel (U.S. Nuclear Regulatory Commission, 1975).

k) Safety Training and Education: Nuclear Sector needs employees who are competent, acquainted of permissible limits to industrial processes they undertake and when emergency response actions relating to the process should begin. Machine/Plant operators should undergo orientation examinations, with emphasis on the safety of operations as well as the respective emergency response procedures. Equipping staff with requisite Occupational Safety and Health knowledge will enhance plant safety and capacity to prevent and respond to safety and health incidences. There is a need to introduce and encourage civic education through media, by NuPEA, to inform the public on nuclear energy to alleviate public negative perceptions on the sector. The government should make use of international trainings on safety offered by IAEA to equip staff will revenant knowledge and hands-on skill.

l) Severe Weather Facility Shutdown and Emergency Response Plans - In the event of extreme weather phenomenon such as el-nino, la-nina, hurricanes, heat strokes, sand storms and flash floods mitigation measures should be in place specific to the location of the nuclear infrastructure. Pollution control, disaster mitigation and prevention measures for the aforementioned weather phenomenon should be provided. Facility structures should be

designed and constructed to withstand the expected weather conditions for the region and have an area designated for safe refuge, if appropriate.

m) Security - Access to the nuclear facilities by unauthorized parties should be avoided by means of gates. Means for detecting intrusion (for example, closed-circuit television) may be considered, allowing the control room to verify the conditions of the facility. Additional active and passive security measures should be defined on the basis of a site-specific risk assessment. Security is key in NPPs as information landing to a wrong receptor can put the whole operation, country and region in jeopardy and risk of nuclear attacks and cybercrime.

n) Capacity Building -The Nuclear Power sector in Kenya is at its infancy and therefore important skills and knowledge to manage the challenges it may present may be lacking. Officers of all relevant key agencies including but not limited to NuPEA, KRA, KEBS, NEMA, DOSHS, ERC, KETRACO, etc. ought to be equipped with the necessary skills to manage the NPP including standard setting, regulatory aspects, security and safety aspects and radioactive incident/ accident management.

The following set of capacity building areas will be useful:

- General course in Nuclear Power Operations;
- Bunkering operations and Management;
- Nuclear Accident Insurance;
- Radiation Emissions Management and Response;
- Ecosystems Radiation Contamination Mapping;
- Radioactive Waste Management;
- Nuclear Safety and Security;
- Nuclear Operations Risk Assessment and Management;
- Nuclear Operations Occupational Health and Safety;
- Environmental Health and Safety Regulations, Compliance and Enforcement Skills

8.5.1 Mitigation measures for negative Cumulative Impacts

Mitigation of cumulative impacts is best approached through a multi-stakeholder's approach. Some of the actions that may be needed to effectively manage cumulative impacts include the following and are summarized in Table 8-4: A highlight of key mitigation measures for described negative Cumulative Impacts

- Project design changes to avoid cumulative impacts (location, timing, technology).
- Adaptive management approaches to project mitigation
- Mitigation of project impacts by other projects (not under control of the proponent to further minimize impacts).
- Collaborative engagement in other regional cumulative impact management strategies.
- Participation in regional monitoring programmes to assess the realized cumulative impacts and efficacy of management efforts.
- Effect monitoring needed to assess the realized cumulative impacts is clearly defined and implemented.
- Ensure multiparty regional mitigation and/or management (e.g., additional mitigation of other developments, offsets, management programmes) that may be needed to effectively manage cumulative impacts is also identified
- Support from other stakeholders (County Governments, developers and communities) is sought to implement it.

Table 8-4: A highlight of key mitigation measures for described negative Cumulative Impacts

Impact	Mitigation
Increased demand for housing / Population influx	▪ Develop an influx-management plan
In0creased demand for water use	▪ Come up with measures of optimizing the existing water resources such as rain harvesting and water recycling technologies ▪ Sensitizing the occupiers in all the zones on water conservation initiatives ▪ Perform scheduled maintenance on the water supply infrastructure to reduce any leakages
Loss of biodiversity	▪ Avoid clearing indigenous vegetation ▪ Ensure replacement of any cleared vegetation is done after development ▪ Training of staff and workers
Increased air pollution	▪ Instigate measures of air pollution control before releasing any harmful substances into the air ▪ Sensitize on the use of non-sulphur fuels for different purposes in all the zones. ▪ Sensitize neighbouring community against open burning of waste
Increased noise pollution and vibration	▪ Only operations that meet the required permissible noise levels should be allowed to operate at night ▪ Sensitization of motorists against unnecessary noise making such as engine raving ▪ Acquiring of requisite permits where necessary such as blasting permits
Involuntary resettlement	▪ Development of Resettlement Policy Framework (RPF) ▪ Development of project Resettlement Action Plans (RAP)
Increased solid waste generation	▪ Develop a waste management plan for the NPP ▪ Develop a radioactive waste management policy and strategy
Impacts on soil	▪ Put measures in place to control the spillage of hazardous substances and wastewater into the soil. ▪ Ensure that the wastewater system in all the zones is adequate and made from good quality materials to prevent spillage into the soil.
Impacts on water resources	▪ In collaboration with the relevant agencies such as the Water Resources Authority, implement water resource conservation measures

9 CHAPTER TEN: NPP STRATEGIC ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (ESMMP)

Below is a proposed Strategic Environmental and Social Management and Monitoring Plan (ESMMP) to be adopted and implemented by various stakeholders and government agencies in the short, medium and long terms. The ESMMP has been phased into a series of progressive 2 years, 4 years and 6 years depending on the urgency of the recommendations/ mitigation measures proposed.

- ✓ First 2 years- Most urgent recommendations
- ✓ First 4 years- Urgent recommendations
- ✓ First 6 years- Not urgent, but long term and important recommendations

The table below, which is an integration of NPP milestones phases and milestones and the environmental activities upon each phase, gives general guideline to the ESMMP. The figure was adopted from, IAEA's guide on Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes (Series No. NG-T-3.11 - Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes) (IAEA, 2014).

Table 9-1 the proposed environmental and social management plan for the KNPP

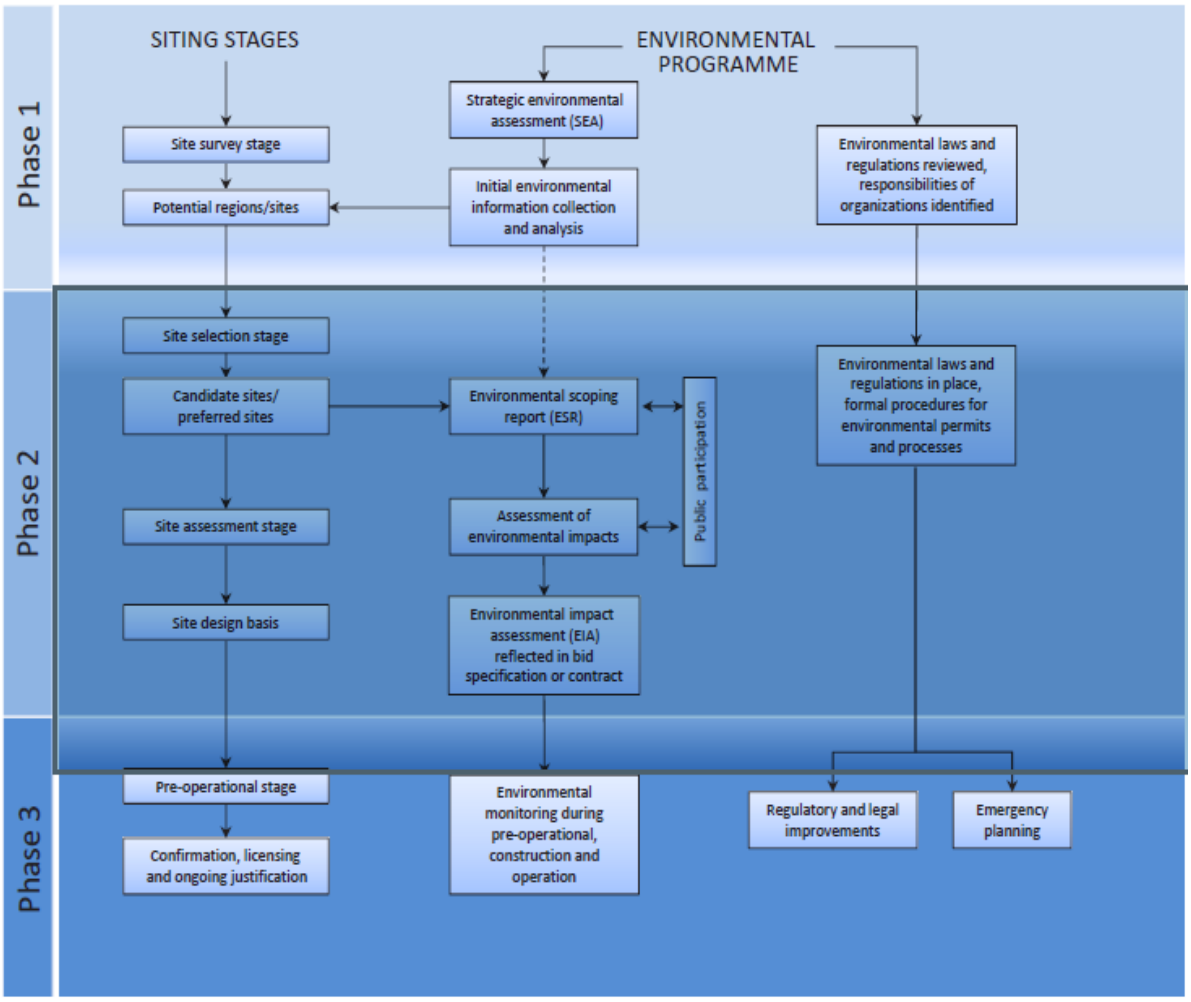

Figure 9-1: Phased approach to address environmental issues in NPPs

Source (AIEA, Series No. G-T- 3.11) (IAEA, 2014)

Table 9-1: The NPP Strategic Environmental and Social Management and Monitoring Plan

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
•	***Environmental Issues***							
1.	Radioactive waste and spent fuel management from the nuclear reactors	• *Development of a national policy and strategy on Radioactive Waste management (RWM)and Spent Fuel Management (SFW)* • *Development of capacity in NEMA to be able to regulate on matters of RWM and SFW* • *Creating a special unit NEMA that deals with nuclear related environmental issues* • *Develop Spent Fuel and Radioactive Waste Management user's guide based on local and international legal procedures and environmental standards*	NEMA				• *Policies formulation* • *Strategies development* • *Available of special unit at NEMA*	80
2.	Impact Important Bird Areas	• *Mapping and conservation of the IBAs in areas of close proximity to the candidate sites.* • *Colleting baseline information on IBAs prior to construction activities and commissioning of the NPP for future monitoring of possible impact upon such ecosystems* • *Development of sectoral policies statement on conservation of international and nationally ecologically important ecosystems* • *Conservation of habitats: Support mapping of protected area and development of updated maps in proximity to the candidate sites* • *Environmental Conservation Plans*	NMK. NuPEA				• *Availability of maps and baseline information* • *Availability of policies and conservation plans*	120

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
3.	Nuclear Power Programmes Impacts on Water Resources	• *Develop technical guidelines for nuclear power operations within the selected candidate sites* • *Conservation of habitats: Support mapping of protected sites Ensure Linkages to Wise Use of Water and Protection of Water Bodies and Wetlands*	NEMA/WMA				• *Availability of technical guidelines* • *Availability of maps*	40
4.	Nuclear Power activities' potential for ground water contamination	• *Development guidelines to cover groundwater resources (see, IAEA guidelines: No. NP-T-2.6- Efficient Water Management in Water Cooled Reactors) (IAEA, 2012).*	NEMA/WMA				• *Availability of guidelines*	20
5.	EIA methodology and NPP Decommissioning issues	• *Development of National Guidelines for Environmental and Social Impact Assessment for both Nuclear Power and Radioactive Facilities and guidelines for Project Affected Persons Consultation and Stakeholder Participation* • *Development of Policy and strategy for decommissioning of nuclear and radiological facilities* • *Mainstream Decommissioning provisions on EIA for decommissioning plants by AIEA into the National Environment Impact Assessment and Audit regulations (IAEA safety standards for decommission of facilities: - SERIES No. GSR Part 6) (IAEA, 2014)* • *Integration of Health Impact Assessment into the EIA Process*	NEMA/ KNRA/ NuPEA				• *Availability of guidelines on ESIA* • *Availability for Policy and Strategy for decommissioning* • *Evidence of amendment of EIA and Audit regulations* • *Evidence/ progress of EIA experts capacity building*	100

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
		• *EIA Experts capacity building on Nuclear facilities and decommissioning EIA process*						
	Social Issues							
6.	Employment impacts and Population Migrations/ Influx Management	• *Development of Population migrations/ influx management plans by Ministry of Health/ County Government Health Departments in candidate areas and health issues* • *Development and Implementation of Local Content Policy and Strategy*	NEMA				• *Availability of influx management plan* • *Availability of local content Policy and strategy*	20
7.	Preservation of Historical, Cultural Resources and Heritage Sites	• *Capacity building of EIA Experts, NEMA and Lead Agencies on Heritage Impact Assessment* • *Conservation of habitats: Support mapping of protected area and development of updated maps in proximity to the candidate sites*	NEMA/ NMK				• *Evidence of Experts Capacity building* • *Submitted Reports review on inclusion of Historical and Cultural Assessment* • *Availability of maps*	20
8.	Gender and Equity	• *Undertake Gender Assessment for the Nuclear Sector'* • *Mainstreaming Gender issues and Vulnerability in the Nuclear Sector* • *Preparation and implementation of the Vulnerable and Marginalized Groups Framework (VMGF)*	NEMA				• *Evidence of gender assessment* • *Evidence for VMGF*	60
9.	Human Rights	• *Develop monitoring programmes to ensure application of human rights in the nuclear sector*	KNHCR				• *Availability of monitoring programmes* • *Availability of User Guide*	40

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
		• *Community user Guide for Environmental and Social Impact Assessment*					• *Evidence of Human Right consciousness in NPP*	
10.	Local livelihood and Community Development	• *Promotion of Community Development Programmes* • *Equitable Distribution and Allocation of Revenue and other Benefits from the Nuclear Sector*	NLC, NuPEA				• *Evidence of Programmes at sites* • *Evidence of equitable distribution of revenue and benefits*	40
11.	Public consultations, Public Perception on Nuclear Power Programmes	• *Guidelines for Public consultation and information disclosure* • *Public Consultations and Stakeholder Engagement* • *Development of a National Communication Strategy for the Nuclear Sector and implementation of a Public Education Awareness Programme* • *Development of an environmental information management system for nuclear Sector* • *Development and implementation of a Public Participation and Consultation National Manual for Nuclear Power Sector*	NEMA/ NuPEA				• *Availability of: -* - *Consultation guidelines* - *National communication strategy* - *Environmental Management System* - *Consultation manual* • *Public response and feedback on consultation and involvement*	100

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
12.	Nuclear Power Programme Security Concerns	• *Development and Enhancement of GoK security strategy/ master plan of the nuclear sector* • *Maintenance of counter-terrorism capabilities, nuclear anti-cybercrime capabilities, prevention strategies and operational responses to that pose threat to NPP*	NEMA/KMA/ Ministries of Defence and Interior Coordination				• *Availability of efficiency of strategies*	40
	Economic Issues							
13.	Weapons proliferation and terrorism	• *Integration of Nuclear Activities into the National Security Master Plan* • *Development of policy and strategy for nuclear power programme*	NEMA/KMA/ Ministries of Defence and Interior Coordination				• *Availability of efficiency of strategies*	50
14.	Human Resource Capacity	• *Capacity building for ESIA experts /consultants, relevant NEMA staff and lead agencies' contact persons on Integrated Environmental and Social Assessment for the nuclear sector projects* • *Establishment of a Nuclear Unit at NEMA to handle all environmental matters for the nuclear sector projects* • *Lead Agencies Capacity Building and Inter-Agency Coordination including Streamlining Environmental Roles and Responsibility* • *Enhancing capacity for the Institution of Nuclear Science at local universities and TVET centres*	NEMA/ CUE/TVTA				• *Number of personnel trained* • *Evidence of Nuclear Unit at NEMA* • *Number of Lead Agencies trained* • *Feedback on capacity building* • *Evidence on university and colleges curriculum development*	100

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
		• *Integrating Environmental Safety and Health and Disaster Management into National Education Curriculum, so as to become part of National Education System. This would aid in mitigating health and safety risks in the downstream nuclear sector.*						
15.	Infrastructural Capacity	• *Undertake Capacity Infrastructure Assessment needed for integration of the NPP such the grid capacity,*	MOE				• *Efficiency of infrastructure to support NPP* • *Reports on assessment on capacity*	20
16.	Revenue and benefit Sharing	• *Develop local content strategy and mainstream all local legal structures on local content with regard to infrastructural development*	AG, MOE				• *Availability of strategy* • *Revenue collected* • *Revenue shared*	20
17.	Economic Crime and Corruption	• *Promotion of Institutional Transparency and Environmental Accountability* • *Develop clear mandate between ERC and KNRA on matters of Nuclear Activities regulation* • *Delineate the mandate of the nuclear regulatory and that of the NPP owner (*NuPEA*)*	MOE				• *Efficiency of strategies put in place* • *Number of complaints received* • *Gaps assessment*	60
18.	Nuclear Power Programme Implementation and Operational Costs	• *Adopt Private Public Partnership approach*	MOE, Treasury				• *Collaborations with various partners* • *Efficiency of strategies put in place*	20
	Occupational and Community Health and Safety Issues							

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
19.	Nuclear Safety	• *Ratification of Conventions on nuclear safety and domestication of their provisions into the local legal structure;* • *Development of nuclear legislative structures/ domestication of international legal structures' provisions on nuclear power development;* • *Mainstreaming OSHA, 2007 to include the IEAE safety provisions and provisions of relevant conventions on nuclear activities to which Kenya is party;* • *Public awareness creation by* NuPEA *on proposed NPP, its impacts and security and safety requirements;* • *Coming up with National Nuclear Safety Guidelines* • *Disaster Risk Reduction and Emergency Response Management Plans;* • *Coming up with National Emergency Response Plan for the energy sector with specific plans for each sub-sector* • *Formulation of a comprehensive national legislation framework nuclear accidents, response, liability and compensation and agreements, memorandum of understanding for response between different parties that are consistent to the international and national provisions*	NuPEA /DOSHS				• *Evidence of legal structure mainstreaming to include safety standards, and provision from international organizations and conventions on nuclear safety* • *Availability of guidelines* • *Level of public safety awareness* • *availability of emergency plans*	200

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
		• *Severe Weather Facility Shutdown and Emergency Response Plans*						
20.	Health Impacts of Nuclear Power Programmes	• *Build capacity on Heritage Impact Assessment (HIA) and develop guidelines for undertaking HIA* • *Development of guidelines for Health Impact Assessment (HIA) and establish procedures for entrenchment in the ESIA process*	NEMA/NMK				• *Assessment or ESIA reports on incorporation of HIA*	20
21.	*Encroachment of the Way Leave and buffer zones*	• *Establishment of a special department for wayleave acquisition, record keeping, monitoring and enforcement of wayleaves encroachment* • *There should be a clear set of guidelines and regulations provided with regards to safe distances/buffer zones for developing NPP facilities.* • *Formulation of policies to address clear safety buffer zones on various NPP infrastructure and operations*	DOSHS/ NLC/KEBS				• *Evidence of special department and requisite policies* • *Availability of set guidelines* • *assessment of reports on buffer and wayleave status on encroachment*	60
22.	*Safety Training and Education*	• *Operationalization of the Nuclear Training Fund*	DOSHS/ MOE				• *Accounts assessment*	20
23.	*Community Health and Safety*	• *Undertake regular community health assessment of potential candidate areas*	NEMA				• *Reports' availability* • *Community feedback*	20
24.	*Occupational Health and Safety Capacity Building*	• *Staff recruitment and training on NPP related health and safety issues* • *Incorporation of Health and Safety courses into the academic curriculum in the Universities*	DOSHS				• *Number of Staff recruited* • *Efficiency of trainings ad capacity building programmes*	60

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
		• *Development of short courses on Nuclear related Occupational Health and Safety for training to the lead agencies*						
25.	*Information and Advisory Services on OSH*	• *Development of policy guidelines in the relevant codes of practice for OSH Auditing and OSH Performance Monitoring in the nuclear sector*	NuPEA /DOSHS				• *Availability of policy structures and implementation status*	20
26.	*Duplication of Roles by Local Statutory Institutions*	• *Review of the Nuclear Regulatory Act, 2019 to ensure its passing by parliament and presidential ascent;* • *Finalization and enactment of the process of development and enactment of the National Energy Policy 2012* • *Establishment of Nuclear Energy Regulator charge with independent mandate for Policy and legislation formulation* • *Delineation of development of National Nuclear Policy and Legal structures from the NPP owner (*NuPEA*) in order to ensure the independence of the regulator* • *Develop an environmental management and coordination regulation for nuclear sector* • *Harmonization of duplicated roles performed by NEMA, DOSHS, ERC, and KEBS in administering of EHS issues in the energy sector.*	ERC/ NEMA/ KNRA				• *Availability of regulation* • *Audit of agencies' mandates with regard to NPP*	120
27.	Disconnect of the Ministry of Health Services at the County Level	• *Specialized departments in public hospitals to deal with NPP related health issues with adequate relevant infrastructure. This special department to be cascaded from*	MoH/ KNRA				• *Human resource capacity and understanding on NPP related health issues*	20

SN	Issue Identified	*Activities/ Recommendations/mitigation measures*	Responsible Implementing Agency	Time Frame			Monitoring indicators	Budget ('000,000') (KES)
				2020-2021	2022-2023	2024-2025		
		the national referral hospitals to the county level '5' hospitals.					• *Availability of Special departments*	

Total Estimated Cost is KES **1,590,000,000**

Source: (SGS, 2019)

10 CHAPTER ELEVEN: CONCLUSION

The Nuclear Power Programme is a worthy investment towards ensuring that Vision 2030, the Least Cost Power Development Plan reduction of carbon footprint as well is achieved for a sustainable development. The Plan is part of the interventions by the national government through the Ministry of Energy to ensure the 4000 MWe by 2030. The Plan is likely to contribute significantly in spurring up an economic and industrial development in Kenya, in line with the Big 4 Agenda, as well as in the East African Region through power interconnectors under construction and those planned for.

The NPP as envisioned would create an economic turn-around in Kenya with accessible, cheap and reliable electricity for the residents. Three potential candidate sites (Lake Victoria region; Lake Turkana Basin, and the Coast region were sufficiently analysed through the following parameters: geology, seismology, tectonics, soils, vegetation, hydrology, demographics and urbanization, transport infrastructure (roads, rail, ports, airports), electric grid network, socio-economics (tourist sites, national parks/reserves), environmental assets (RAMSAR sites, wildlife areas, floodplains/wetlands) and security. and Site G scored highest in the ranking and this is attributed to the sparsely populated and aseismic Lamu basin and the fact that major geologic faults occur very far from the site.
However, after application of the sensitivity analysis, Site G (in Lamu County) was avoided, because the cost of corrective engineering measures would increase the NPP Construction costs. Thus, Site B is the Preferred Site, followed by Site D. The report also assesses the alternatives to the plan, cumulative impacts and climate change vulnerability associated with the NPP.

The anticipated environmental, social and economic issues have been adequately identified and assessed; recommendations on mitigations measures proposed; and an environmental and social management and monitoring plan drafted for ease of NPP's environmental and social administration and follow-up. The report has also detailed assessments, gaps and recommendations on current policy, legal, regulatory and institutional framework relevant to the NPP with key being institutionalization of a Nuclear Energy Regulator independent from the NPP owner with mandate to develop key sectoral policies, strategies and taking lead role in development of legislative and regulative structures for the sector.

In view of this, with the undertaking of NuPEA as the Nuclear Energy Programme Implementing Organization (NEPIO), it is our recommendation that NEMA approves this SESA report to allow for the execution of the plan and realization of envisioned developments.

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12 ANNEXES

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