DEVKI STEEL MILLS LTD

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NAIROBI

PROPOSED DEVELOPMENT OF 60 MEGAWATTS WIND FARM AT /SOUTH SAMBURU GROUP RANCH/88

COUNTY

ENVIRONMENTAL IMPACT ASSESSMENT STUDY REPORT

Compiled by:

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EXECUTIVE SUMMARY

This report presents findings of an Environmental Impact Assessment Study for proposed construction and operation of a 60 megawatts wind farm by Devki Steel Mills Limited to generate electricity to be sold to the national grid as per the Feed-in-Tariff Policy for wind. The proposed project which is to be located at Samburu off Mombasa-Nairobi Road within KinangoSub-County in County will be located on plot no /South Samburu group Ranch /88 owned by Devki Steel Mills Limited.

This site was considered suitable for the proposed wind farm because:-

- ✓ The land is owned by Devki Steel Mills Limited effectively eliminating requirements of land acquisition and associated negotiations. (see attached sale agreement)
- ✓ The site landscape is characterized as flat, open and non-complex which makes its accessibility relatively convenient and movement of turbines during installation, service and maintenance relatively convenient.
- ✓ The very dominant direction of wind on this site is south, wind speeds are steady and occurrence of very high wind speeds is low, site wind speeds shows relatively small distribution, spread around the central and mean values are small.
- ✓ These site wind conditions favour the site for production of electricity from wind using a low-wind turbine that is a turbine which reaches rated capacity at a low wind speed rather than one with higher.

The proposed wind farm will be built by installing thirty-eight (38) wind turbines to generate electricity to the national grid. The design components of the wind farm will include wind turbines complete with all necessary auxiliary facilities, overhead power lines and access road. Electricity generated will be fed to an existing nearby sub-station and power transmission grid within the premises of Devki Steel Mills Limited Samburu Plant.

The turbines to be installed will be Vestas V90 each with the capacity of 3MW; pitch regulated upwind wind turbine with active yaw and a three-blade rotor. Operating data for the turbines is as follows; rated power 3,000 kW (50Hz); cut-in wind speed that is the lowest mean wind speed at hub height at which the wind turbine starts to produce power will be 3-5 m/s; the rated wind speed that is the lowest mean wind speed at hub height at which the wind turbine produces the rated power will be 15 m/s; while the cut-out wind speed that is the maximum wind speed at hub height at which the wind turbine must be shut down will be 25 m/s.

It is envisaged that the potential positive impacts from the proposed wind farm will include provision of affordable clean, indigenous and reliable energy, minimisation of reliance of conventional, mainly fossil fuel-based electricity generation methods that emit greenhouse gasses, contribution to climate change mitigation among others while potential negative impacts may include negative impacts on local avifauna, other fauna, flora, local aesthetics in terms of visual impacts, bring about issues of noise among others.

The following are the proposed mitigation measures for potential negative impacts.

POTENTIAL NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURE
Construction phase	
Impacts on terrestrial flora and fauna- vegetation clearing Establishing rows of wind turbines with inter-connecting roads will involve the clearing of vegetation which will destroy local fauna habitats, destroy vegetation and displace local fauna	- Careful site selection for the wind farm and associated transmission lines to avoid or minimize the clearing vegetation and destruction of associated fauna habitats. - Configuring wind turbines and access roads to minimize the clearing of vegetation and destruction of associated fauna habitats. - Limit vegetation clearance and removal to actual location/installation of the turbine and allied infrastructure. - Avoid off-road driving by wind farm personnel that can result in destruction of flora and fauna on site
Noise and vibration	- Limit the construction and turbine installation to day time. - Ensure equipment like heavy duty cranes being used to install the turbines are appropriately serviced and maintained. - Put in place a comprehensive noise and vibration conservation

	programme which will include noise and vibration level monitoring, use of noise attenuators, training and use of appropriate personal protective equipment - Ensure the provisions of Environmental Management and Coordination (Noise and excessive vibration control) Regulation, 2009 are adhered to.
Particulate matter (dust) emission	- Regular sprinkle water on opened up dusty access roads - Secure construction site with dust screens - Provide construction workers with appropriate personal protective devices - Monitor dust levels. - Ensure the provisions of the Environmental Management and Coordination (Air Quality) Regulations 2014 are adhered to.
Occupational injuries	- Ensure only skilled and experienced workers are involved in the construction of the wind farm and allied infrastructure. - Ensure suitable, appropriate, well serviced and maintained equipment are availed to the workers. - Workers working at height and in confined areas must be provided with appropriate safety equipment. - An all equipped first aid station to be on site with trained and

	experienced first aiders, stand by ambulance and referral hospital. - Ensure that the provisions of the Occupational Safety and Health Act, 2007 are adhered to.
Traffic inconvenience along Mombasa-Nairobi Road	- Permission to be sought from Kenya National Highway Authority for transportation of abnormal loads (wind turbines) prior to transportation. - An escort vehicle one in front and one behind the truck transporting the turbines to be provided. - Turbines to be transported during daylight only. - Notice to be issued on local press of transportation of abnormal loads on the said road to inform other potential road users on order for them to exercise extra caution.
Operational phase	

Visual impacts- some people consider large wind turbines to be an eyesore. Shadow flicker:This is a specialized type of visual impact, in which spinning wind turbines create an annoying effect of rapidly-blinking shadows when the sun is near the horizon.	- Thorough stakeholder engagement, including prior consultation, participatory decision-making, and information disclosure and dissemination. - Appropriate site selectionto avoid areas used for tourism and recreation.

	- Adjusting the location of turbine rows or individual turbines to reduce perceived visual impacts. - Choose wind power equipmentwith aesthetics in mind (where consistent with other objectives), such as a smaller number of (larger) turbines and reduced or different night lighting. - Careful site selectionto locate turbines where they would not produce shadow flicker around human dwellings. - Use planning tools—standard industry software that predicts the location and timing of shadow flicker. - Stakeholder engagementwith potentially affected households and businesses. - Create a visually balanced, simple and consistent image by adopting a regular wind turbine tower layout format such as a double line, a triangle, or a grid for regular landscapes such as an open or levelled space as is the case of the proposed project site. - Turbine colours to be white, off-white or grey which gives people a feeling of cleanliness and efficiency and engage the turbines to the backdrops at different views and in

	different weather conditions. - Design of wind farm according to the peculiarities of the site and with sensitivity to the surrounding landscape. - Locate the wind farm at least reasonable distance from dwellings. - Selection of wind turbine design (tower, colour) according to landscape characteristics; - Selection of neutral colour and anti-reflective paint for towers and blades. - Underground cables - Lights for low-altitude flight only for more exposed towers.
Noise disturbance - Wind turbines produce bothmechanical noise (turbine hum) andaerodynamic noise (rotor swish), which humans readily notice within300 m or so.	- Careful site selectionto locate turbines an adequate distance from human dwellings. - Use planning Tools—standard industry software that predicts specific noise impacts on nearby buildings. - Stakeholder engagementwith potentially affected households and businesses. - Improved blade design to reduce the aerodynamic noise by decreasing rotational speeds to under 65 m/s at the tip; and

	using pitch control on upwind turbines, which permits the rotation of the blades along their long axis - Application of upwind turbines to reduce low frequency noise. - Use of special gearboxes for wind turbines instead of standard industrial gearboxes. Steel wheels of the special gearbox have semi-soft and flexible cores with hard surfaces to ensure strength, to extend the lifetime of the equipment, and to muffle noise. - Consider direct drive wind turbines without any gearbox or high-speed mechanical component which operate more quietly or variable-speed turbines which create less noise at low wind speeds than the constant-speed turbines.
Impacts on avifauna and bats - bird and bat mortality Birds collide with spinning wind turbines; and power transmission lines. Bird species groups of special concern include raptors, seabirds, migratory species, and birds with aerial flight displays. Bat mortality occurs when bats collide with spinning turbines or closely approach them, causing lung damage from decompression.	- Careful site selection to avoid building wind farm within important bird habitats and bird migration routes. - Bird flight activities in a zone of 200-500 m surrounding the planned wind farm should be recorded and analysed. Fight heights, directions, species, and behaviours of birds should be studied systematically. - Restrict construction activities to non-breeding periods for

	avifauna to help reduce the negative effects of bird disturbance. - Structural design improvements to reduce bird mortality by enlarging the blades and slowing the rotational speed of the turbines. - Pattern paint the blades to increase the visual acuity of raptors. - Provide night illumination by lighting the turbine tower to improve blade visibility at night to reduce bird and bat collision with turbine towers at night - Increased turbine cut-in speed (which is the lowest wind speed at which the rotor blades are spinning and generating electricity for the grid) to minimise bat mortality. - Short-term shutdowns (in which the rotor blades do not turn during peak migration events) to minimise bird mortality - The direction of tower layout should be properly designed to reduce the effects on bird migration.

Reception of radio waves and weather radar electromagnetic interferences- Operating wind turbines can interfere with the signals received by radar andtelecommunications systems, including aviation radar, radio, television, and microwave transmission. These impacts tend to be significant when wind turbines arewithin the line-of-sight of the radar or telecommunications facility	- Careful site selectionto avoid installing turbines within the line-of-sight of radar or telecommunications facilities. Consider - using turbine blades made from synthetic materials, which produced less electromagnetic interference compared to steel blades. - Install deflectors or repeaters to overcome the problem of already existing wind turbine induced electromagnetic interference.
Local climate change	- Careful site selection for location of wind farm to ensure the wind farm is located in regions where wind energy is abundant and the frictional dissipation is high in this way, the wind energy will be harvested instead of losing as frictions. - Rotor generated turbulences to be reduced through improved rotor and blade designs and a proper design of turbine spacing and pattern.
Blade throw- This is the risk of a loose rotor blade being thrown as a result of severe mechanical failure.	- Careful site selectionto locate turbines an adequate distance from human dwellings - Timely servicing and maintenance of the turbines as per manufacturer‘s schedule.

Decommissioning phase	
Injuries and accidents	- Ensure that the provisions of the Occupational Safety and Health Act, 2007 are adhered to. - Ensure only skilled and experienced workers are involved in the decommissioning of the wind farm and allied infrastructure. - Ensure suitable, appropriate, well serviced and maintained equipment are availed to the workers. - Workers working at height and in confined areas must be provided with appropriate safety equipment. - An all equipped first aid station to be on site with trained and experienced first aiders, stand by ambulance and referral hospital.
Noise and vibration	- Limit the dismantling of the turbines and allied infrastructure to day time. - Ensure equipment used in the decommissioning of the entire wind farm are appropriately serviced and maintained. - Put in place a comprehensive noise and vibration conservation programme which will include noise and vibration level

	monitoring, use of noise attenuators, training and use of appropriate personal protective equipment

	- Ensure the provisions of Environmental Management and Coordination (Noise and excessive vibration control) Regulation, 2009 are adhered to.
Dust	- Regular sprinkle water - Secure decommission site with dust screens - Provide decommissioning workers with appropriate personal protective devices - Monitor dust levels - Ensure the provisions of the Environmental Management and Coordination (Air Quality) Regulations 2014 are adhered to.
Waste generation	- Ensure all the waste generated in handled and disposed as provided for in the Environmental Management and Coordination (Waste Management) Regulations, 2006. - Explore possibility of re-use and or recycling

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1. BACKGROUND INFORMATION

1.1 Introduction

This is an Environmental Impact Assessment Study Report for the proposed construction and operation of a 60 megawatts wind farm by Devki Steel Mills Limited (DSML). The electricity to be generated from the wind farm is intended for sale to the national grid as per the Feed-in-Tariff Policy for wind. This EIA Study Report is carried out and prepared as provided for in section 58 (1) of the Environmental Management and Coordination Act, 1999 and Regulation 7 of the Environmental Impact Assessment and Audit Regulations 2003.

1.2 Project definition

The proposed wind farm project will involve installation of 38 wind turbines. The electricity generated from the wind farm will be evacuated via overhead cables to an existing sub-station within Devki Steel Mills Ltd Samburu Plant premises for feeding in to the national grid.

1.3 Proposed project location

The proposed wind farm project will be located within the sea facing section of land parcels /South Samburu Group Ranch/88 owned by Devki Steel Mills Limited (figure 1). Located off Mombasa- Road within Kinango Sub-County in County.. The GPS coordinates of the proposed wind farm are attached herein Appendix 1 is certificate of land titles, certificates of postal search, and letters of confirmation of deed plans,

Figure 1: Proposed project location

1.4 Project proponent

Devki Steel Mills Limited, a private company incorporated with limited liabilities in the Republic of Kenya is the project proponent. The company holds a certificate of incorporation and personal identification number certificate(attached). The company is involved in production construction materials such as barbed wires, chain links, nails just to mention a few and recycling of Scrap metals.

1.5 Project objective and scope

The objective of the proposed project is to construct a 60 megawatts wind farm for generation of electricity for sale to the national grid as per the Feed-in-Tariff Policy for wind. The scope of the

proposed project will cover installation of 38 wind turbines and all associated infrastructure including overhead power lines for evacuation of electricity generated to an existing sub-station.

2. ENVIRONMENTAL IMPACT ASSESSMENT

2.1 Definition of Environmental Impact Assessment

Broadly environmental impact assessment (EIA) refers to the need ‗to identify and predict the impact on the environment and on man's health and wellbeing of legislative proposals, policies, programmes, projects and operational procedures, and to interpret and communicate information about the impacts'(Munn 1979). UNECE (1991) defines EIA as ‗an assessment of the impacts of planned activity on the environment', IAIA (2009) on the other hand defines EIA as ‗the process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of proposed development proposals prior to major decision being taken and commitments made'. Glasson *et.al* (2012) defines EIA as ‗a systematic process that examines the environmental consequences of development actions in advance'. EIA is thus a vital tool that aid formulation of development actions, decision making, an instrument for sustainable development and vehicle for stakeholder consultation and participation (Glasson *et.al* 2012).

2.2 The purposes of EIA

2.2.1 An aid to decision making

EIA is an aid to decision-making. For the decision maker, for example, a local authority, it provides a systematic examination of the environmental implications of a proposed action, and sometimes alternatives, before a decision is taken. The EIA can be considered by the decisionmaker along with other documentation related to the planned activity. EIA is normally wider in scope and less quantitative than other techniques, such as cost-benefit analysis (CBA).It is not a substitute for decision making, but it does help to clarify some of the trade-offs associated with a proposed development action, which should lead to more informed and structured decisionmaking. The EIA process has a potential, not always taken up, to be a basis for negotiation between the developer, public interest groups and the planning regulator. This

can lead to outcome that balances well the interests of the development action and the environment.

2.2.2 An aid to the formulation of development actions

Developers may see the EIA process as another set of hurdles to jump before they can proceed with their various activities; the process can be seen as yet another costly and time-consuming activity in the development consent process. However, EIA can be of great benefit to them, since it can provide a framework for considering location and design issues and environmental issues in parallel. It can be an aid to the formulation of development actions, indicating areas where a project can be modified to minimize or eliminate all together its adverse impacts on the environment. The consideration of environmental impacts early in the planning life of a development can lead to more environmentally sensitive development; to improved relations between the developer, the planning authority and the local communities; to a smoother development consent process, and sometimes to a worthwhile financial return on the extra expenditure incurred. O'Riordan (1990) links such concepts of negotiation and redesign to the important environmental themes of _green consumerism' and _green capitalism'. The growing demand by consumers to goods that do no environmental damage, plus a growing market for clean technologies, is generating a response from developers. EIA can be the signal to the developer of potential conflict; wise developers may use the process to negotiate _environmental gain' solutions, which may eliminate or offset negative environmental impacts, reduce local opposition and avoid costly public inquiries. This can be seen in the wider and contemporary context of corporate social responsibility (CSR) being increasingly practiced by major businesses (Crane et al.2008)

2.2.3 A vehicle for stakeholder consultation and participation

Development actions may have wide-ranging impacts on the environment, affecting many different groups in society. There is increasing emphasis by government at many levels on the importance of consultation and participation by key stakeholders in the planning and development of projects. EIA can be a very useful vehicle for engaging with communities and

stakeholders, helping those potentially affected by a proposed development to be much better informed and to be more fully involved in the planning and development process.

2.2.4 An instrument for sustainable

Existing environmentally harmful developments have to be managed as best as they can. In extreme cases, they may be closed down, but they can still leave residual environmental problems for decades to come. It would be much better to mitigate the harmful effects in advance, at the planning stage, or in some cases avoid the particular development together. This of course leads on to the fundamental role of EIA as an instrument for sustainable developmenta role some writers have drawn attention to as one often more hidden than it should be when EIA effectiveness is being assessed (Jay et al.2007)

2.3 Origins and development of EIA

The first EIA legislation was formerly established in the United States of America in 1969 (O'Riordan and Sewell, 1981), in Europe the 1985 European Community directive on EIA (Directive 85/337) introduced broadly uniform requirements for EIA for all member states (CEC, 1985). In Australia, the Commonwealth EIA system was established in 1974 under the Environmental Protection (Impact of Proposal) Act (Wood 2003, Ellott and Thomas, 2009). The United Kingdom enacted a formal legislation on EIA in 1988 (Glasson *et.al* 2012). China formerly enacted its first EIA legislation in 1979 (Moorman and Ge 2007). In Africa and the Middle East, Israel and Algeria pioneered in enactment and implementation of EIA legislations in 1982, 2003 and 1983, 1990 respectively (Economic Commission for Africa, (2005) Almagi*et.al* (2007). In East Africa Uganda pioneered in enacting EIA legislation in 1998, Kenya EIA legislation was enacted in 2000, and implemented in 2003 (Morara*et.al* 2011).

2.4 The Environmental Impact Assessment Study Report

The environmental impact assessment Study Report for the current proposed project involved, but was not necessarily limited to, the following:

- ✓ Collection of baseline data and information
- ✓ Description of affected environments

- ✓ Initial Participation of primary (grass root) stakeholders
- ✓ Identification and assessment of potential impacts (both negative and positive) of the project to the environment
- ✓ Proposal of possible mitigation measures to curb any potential negative impacts.
- ✓ Development of an appropriate Environmental Management Plan (EMP).

The role of the stakeholder participation was to:

(a) Establish common stakeholder needs and ensure that the project continues to satisfy these needs or even enhance the needs.
(b) Provide background information which will form an important part of baseline data.
(c) Create awareness amongst the stakeholders and sensitise them on environmental issues related to the project.

2.5 Preparation of the EIA Study Report

EIA Study Report prepared for the proposed project contains information on the project, including the following:-

- ✓ Location of the project
- ✓ The objectives of the project
- ✓ Baseline information including legal framework and the administrative arrangement under which the project will operate.
- ✓ The technology, procedures and processes to be used in implementation of the project.
- ✓ Alternative technologies and processes available and reasons for preferring the chosen technology and processes.
- ✓ The wastes to be generated by the project and ways of handling it.
- ✓ A description of potentially affected environments.
- ✓ The environmental effects of the project.
- ✓ An Environmental Management Plan.
- ✓ Provision of an action plan for the prevention and management of foreseeable accidents and hazardous activities.

- ✓ Measures to prevent health hazards and to ensure security in the working environment for the employees and users of the facility, and for management of emergencies.
- ✓ An economic and social analysis of the project.
- ✓ A non-technical summary outlining the key findings, conclusions and recommendations.

2.6 Team of Experts

Newton KaruruGitonga a NEMA Lead expert and also a registered physical planner prepared the Report.

3. POLICY AND LEGAL FRAMEWORK

3.1 Introduction

Legislation, laws, policies and regulations specific to environmental management can directly or indirectly affect the implementation of proposed project. Kenya is a signatory to many international conventions and treaties. Some of the International Treaties and Conventions Binding Kenya include:

- Agenda 21
- The World Commission on Environmental and Development (The Brundtland Commission) – signed/ratifies 1987
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) – ratified 1978
- Convention on Biological Diversity (CBD) – signed/ratified 1992
- United Nations Framework Convention on Climate Change (UNFCCC) – signed/ratified 1994
- United Nations Framework Convention on Climate Change (UNFCCC) – Kyoto Protocol signed/ratified (1997)
- African Convention on the Conservation of Nature and Natural Resources
- International Union for Conservation of Nature

Kenyan Environmental Legislation are determined and enforced through various levels of statutes the majority of which are sector specific. The Environment Management and Coordination Act (EMCA) 1999 is the governing law for the Protection and Development of the Environment in the Kenya. It is considered the base for various environmental regulations and guidelines. Some of the legislation that arse relevant to this project include

□The Environmental Management and Coordination Act of 1999

- □The Environmental Management and Coordination (Water Quality) Regulations, 2006
- □The Environmental Management and Coordination (Waste Management) Regulations, 2006
- □The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009
- □The Public Health Act
- □The Water Act of 2002
- □The Employment Act 2007
- □The Work Injuries Benefits Act 2007
- □The labour Institutions Act 2007
- □The Occupational Safety and Health Act 2007
- □The Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit sharing) Regulations
- □The Environmental Management and Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations 2009
- □The Environmental (Impact Assessment and Audit) Regulations 2003
- □The Land Act 2012
- □The Energy Act 2006
- □The Environmental Management and Co-Ordination (Amendment) Act, 2015
- □The Environmental Management and Co-Ordination (Air Quality) Regulations, 2009

3.2 Binding multilateral agreements/ conventions

3.2.1 Agenda 21

Kenya continues to implement Agenda 21 to support sustainable development through the integration of environmental concerns into the national development policies, plans, and programmes

3.2.2 The World Commission on Environmental and Development (The Brundtland Commission) – signed/ratifies 1987

The commission focuses on the environmental aspects related to development and requires all development projects to be sustainable economically, socially and environmentally. The principle of the organisation emphasis that development project should not have permanent negative impact on the biosphere and in particular the ecosystems.

3.2.3 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) – ratified 1978

This is an international agreement to which countries adhere voluntarily. CITES is legally binding on the parties but it does not take the place of national law. Kenya has signed this convention and it seeks to regulate trade in certain species and their parts, as well as products made from such species e.g. certain tree and fish species. This convention protects forests as habitat for endangered species.

3.2.4 Convention on Biological Diversity (CBD) – signed/ratified 1992

Commonly known as the Bio-diversity Treaty, this is one of the treaties that was open for signature at UNCED, 1992. This convention is a practical tool for translating the principles of Agenda 21 (Rio Earth Summit) into reality. The Convention is dedicated to promoting sustainable development. Parties to the treaty solemnly affirm sovereign rights over their biological sources, while accepting responsibility for conserving biological diversity and using biological resources in a sustainable manner. All developers need to ensure their operation promote national strategies, legislation, plans and programmes and avoid loss of biodiversity within their property.

3.2.5 United Nations Framework Convention on Climate Change (UNFCCC) – signed/ratified 1994

The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. Kenya and other states gather and share information on greenhouse gas (GHG) emissions, national policies and best practices.

3.2.6 African Convention on the Conservation of Nature and Natural Resources

This convention reaffirms the importance of natural resources both renewable and nonrenewable, particularly the soil, water, flora and fauna. The main objective is to facilitate sustainable use of the above resources. The convention was adopted in Algiers on 15th September 1966 and came into force on 16th June 1969.

3.2.7 International Union for Conservation of Nature

International Union for Conservation of Nature (IUCN) helps the world find pragmatic solutions to our most pressing environment and development challenges. IUCN categorises protected areas by management objective and has identified six distinct categories of protected areas according to their management objectives. The categories are recognised by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation.

3.3 Kenya Environmental legislation

3.3.1 Environmental Management and Co-Ordination Act (EMCA), 1999

The EMCA, 1999 provides the legal framework for management of the environment and other related issues in Kenya. It is the policy of the Government of Kenya that EIA be conducted for planned projects that are likely to cause, or will have, significant impacts on the environment, so that adverse impacts can be foreseen, eliminated or mitigated. It is also policy of the government that the EIA

process be interdisciplinary, fully transparent so that the stakeholders have access and can express their views. This is in order that the process serves to provide a balance between environmental, economic, financial, social and cultural values for purposes of sustainable development of the entire country. The policy therefore, through the use and application of EIA, seeks to integrate environmental concerns in all development policies, plans, projects and programs at national, regional, district and local levels with full public participation of all stakeholders.

The undertaking and administration of the EIA process for the proposed project will be in accordance with the Environmental (Impact Assessment and Audit) Regulations, 2003. Some of the administrative procedures of EMCA include:

- The EIA process will be applicable to both public and private sector development projects and programs.
- The projects to be subjected to EIA are specified in the second schedule of the EMCA, 1999. Besides the scheduled activities, the Act empowers the Minister in charge of environment to prescribe for EIA appraisal any other activities, which in his view carries significant environmental impacts.
- NEMA will designate environmental committees to oversee implementation at Provincial and District levels.
- NEMA will initiate public participation through uses of public notices and meetings with regard to proposed EIA studies and review of reports.
- A scheduled activity will not receive the necessary authorisation from NEMA to proceed, until all EIA requirements have been fulfilled and accepted by NEMA and relevant lead agencies.
- EIA License will be granted when NEMA and the Minister are satisfied that an EIA has been satisfactorily conducted and that an Environmental Management Plan of the activity has been sufficiently developed.
- Complains with regard to compliance with EIA licensing requirements and procedures that NEMA may not resolve will be subject to a review by the Environment Tribunal. Under the Act there are general provisions for appeal to high courts and to bring proceedings in a court of law where

necessary, for judicial review by third parties including concerned citizens and/or organisations other than the Government.

3.3.2 The Environmental Management and Coordination (Water Quality) Regulations, 2006

The regulations protect all water resources. Relevant features of this regulation as far as this study is concerned include:-

- ✓ Every person shall refrain from any act which will directly or indirectly cause pollution and it shall be immaterial whether or not the water resource was polluted before the enactment of these regulations;
- ✓ No person shall throw or cause to flow into or near a water resource any liquid, solid or gaseous substance or deposit any such substance as to cause pollution;
- ✓ Discharge of effluent from sewer must be licensed according to the act; and the carry out daily effluent discharge quality and quantity monitoring and shall comply with the standard set in the fifth Schedule of the act.
- ✓ Water abstraction must only be done after approval of an Environmental Impact Assessment study;
- ✓ The regulations also set out standards to be followed for effluent discharge to the environment.
- ✓ No person shall be permitted to use waste water for irrigation purposes unless such water complies with the quality guidelines set out in the 8th Schedule of the act.
- ✓ No person shall use or allow to be used any natural water body for recreational purposes unless the water body meets the quality standards for recreational standards as set out in the tenth schedule of the regulation.

3.3.3 The Environmental Management and Coordination (Waste Management) Regulations, 2006

Relevant parts of this regulation include

- Prohibition of any waste disposal on a public highway, street, road, recreation area or in any public place except in designated waste receptacle;

- All waste generator to collect, segregate and dispose such waste in a manner provided for under these regulations;
- All waste generators to minimize waste generated by adopting cleaner production methods through:
    - improvement of production process;
    - monitoring the product cycle from beginning to the end;
    - incorporating environmental concerns in the design and disposal of products;
- All waste transporters to be licensed according to the act;
- All vehicles used to transport waste to be labelled in such a manner as may be directed by the Authority;
- Collection and transportation of the waste to be done in such a manner no to cause scattering of the waste;
- The vehicle and equipment for waste transportation to be in such a manner not to cause scattering of or flowing out of waste; and
- The vehicles for transportation and other means of conveyance of waste to follow the scheduled routes approved by the authority from the point of collection to the disposal site.
- No person shall engage in any activity likely to generate any hazardous waste without a valid EIA licence issued by Authority
- Every generator of hazardous waste shall ensure that every container or package for storing such waste is labelled in easily legible characters, written in both English and Kiswahili:
  _CAUTION‘, _WARNING‘, _POISON‘, _DANGER‘, _KEEP AWAY FROM UNAUTHORISED PERSON‘ and pictogram of skull and crossbones.

The proposed project shall generate solid wastes and liquid wastes which must be subjected to the mentioned parts of the regulations.

3.3.4 The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009

Part II of the general prohibition of this regulation state that except as otherwise provided for in this regulations, no person shall make or cause to be made any loud, unreasonable, unnecessary

or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment. Part (2) of the general prohibitions stated that 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, intermitted 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 can be controlled without much effort or expense to the person making the noise.

Part 2 of section III states that any person wishing to operate or repair any machinery, motor vehicle, construction equipment or other equipment, pump, fan, air-conditioning apparatus or similar mechanical device or engage in any maisonettes or industrial activity which is likely to emit noise or excessive vibrations shall carry out the activity or activities within relevant levels prescribed in the first schedule to these regulations. Part III section 13 (1) states that except for the purpose specified in sub-Regulation (2)… no person shall operate construction equipment (including but not limited to any pile driver, steam shovel, pneumatic hammer, derrick or electric hoist) or perform any outside construction or repair work so as to emit noise in excess of the permissible levels as set out in the second schedule of the regulations.

3.3.5 The Public Health Act

The Public Health Act outlines how different aspects of a project have to be undertaken to ensure the safety and health of users and neighbours. The Act gives guidelines on construction, maintenance and inspection of drainage system, septic tanks, cesspool or latrines.

3.3.6Water Act 2002

The water Act of 2002 aims to ―make better provision for conservation, apportionment and use of water resources of Kenya‖. Section 5 of the Act prohibits any persons from diverting, abstracting, obstructing or using water from a body of water except as provided for in the Act. The Act stipulates that a permit shall be required in all cases of proposed diversion, obstruction, storage or use of water with exception in the use for domestic purposes. However, general rules within the Act provide that any rights acquired under the permit are subject to the Public Health Act and the Malaria Prevention Act in addition to the Water Act.

Definitions

a) Catchment Area …….. This is a designated area from which rainwater flows into watercourses.
b) Catchment Area Advisory Committee……This refers to a Committee of not more than 15 members appointed by the Minister.
c) ―In-Stream Habitat‖……These includes the physical structure of a water resource and the associated vegetation in relation to the bed of the water course.
d) ―Ground water‖……..Means the water of underground streams, channels, artesian basins, reservoirs, lakes and other bodies of water in the ground, and includes water in interstices below the water table;
e) ―Landholder‖ In relation to lands, means the registered of the land or the person whom the land is otherwise vested by law, and includes:-
   - Any person who by any established right, custom or estate whatsoever is, or is entitled to be the holder or possession of the land;
   - Any person lawfully holding or occupying land in accordance with the provisions of any law empowering the allotment of land upon the promise of title, subject to the fulfilment by the allottee of prescribed conditions; and
   - Any person to whom a mining lease or mining location has been granted under the Mining Act.
f) Pollution…….. In relation to water resource, means any direct or indirect alteration of the physical, thermal, chemical or biological properties of the water resources so as to make it:-

- Less fit for any beneficial purpose for which it is or may reasonably be expected to be used; or
- Harmful or potential harmful to – ▪The welfare, health safety of human beings;

- Any aquatic or non-aquatic life or property; or
- The Environment

g)—Resource Quality‖……..This means the quality of all the aspects of a water resource including:-

- ✓ The water Quality stipulated for the reserve;
- ✓ The Quantity, pattern, timing, water level and assurance of in stream flow;
- ✓ The physical, chemical and biological characteristics of the water;
- ✓ The character and condition of the in-stream and the riparian habitat; and ✓The characteristics, condition and distribution of the aquatic biota.

h)—Riparian habitat‖……..means the dynamic complex of plant, animal and microorganism communities and their non-living environment adjacent to and associated with a water course;

i) —Spring‖…..means water emerging from beneath the surface of the ground otherwise than as a result of drilling or excavation operations;

j) —Stream‖…….Means the water contained in a watercourse, and includes a river;

k)—Water resource‖…….This refers to any lake, pond, swamp, marsh, stream, watercourse, estuary, aquifer, artesian basin, or other body of or standing water, whether above or below ground;

l) —Watercourse‖……..This means any natural channel or depression in which water flows regularly or intermittently, unless declared not to be a watercourse.

Ownership and Control of Water

In the section 3 of the Act, it is therefore stated that every water resource is hereby vested in the State, subject to any rights of user granted by or under the Act or any other written Law.

a) Powers and duties of the Minister

The Minister shall have and may exercise control over every water resource in accordance with this Act.

It shall be the duty of the Minister to promote the investigation, conservation and proper use of water resources throughout Kenya and to ensure the effective exercise and performance by any authorities or persons under the control of the Minister of their powers and duties in relation to water.

The Minister shall be assisted in the discharge of his duties under this section by the director of water.

b) Right to use water

The right to use of water from any water resource is hereby vested in the Minister, except to the extent that it is alienated by or under section 5 of the Act.

c) Acquisition of water rights

In section 6 of the Act, it is stipulated that from the commencement of the Act, no conveyance, lease, or other instrument shall be effectual to convey, assure, demise, transfer or vest in any person any property or right or any interest or privilege in respect of any water resource, and no such property, right, interest or privilege shall be acquired otherwise than under this Act.

Water Resources Management

a) Establishment of the Authority

In section 7 of the Act, there is established Authority known as the Water Resources Management Authority which is a body corporate with perpetual succession and a common seal and shall have power, in and by its corporate name, to sue and be sued and, in the exercise and performance of its powers and functions, to do and permit all such things as may lawfully be done or permitted by a body corporate in furtherance of its objects

b) Powers and functions of the Authority

Section 8 of the Act thereby enlists the powers and functions of the Authority as:-To

develop principles, guidelines, and procedures for the allocation of water resources;

To monitor, and from time to time re-assess, the national water resources management strategy;

To receive and determine applications for permits for water use;

To monitor and enforce conditions attached to permits for water use;

To regulate and protect water resources and quality from adverse impacts;

To manage and protect water catchments;

In accordance with guidelines in the national water resources management strategy, to determine charges to be imposed for the use of water from any water resource;

To gather and maintain information on water resources and from time to time to publish forecasts, projections and information on water resources,

To liaise with other bodies for the better regulation and Management of water resources; and

To advise the Minister concerning any matter in connection with water resources.

c) Catchment Management Strategy

Section 15 of the Act states that the Authority, following the public consultation, shall formulate a catchment management strategy for the management, use, development, conservation, protection and control of water resources within each catchment area.

A catchment management strategy shall:-

- ✓ Take into account the class of water resource and resource quality objectives for the water;
- ✓ Be consistent with the national water resources strategy;

- ✓ Prescribe the principles, objectives, procedures and institutional arrangements of the Authority for the Management, use, development, conservation and control of water resources within each catchment area;
- ✓ Contain water allocation plans which set out principles for allocating water; and
- ✓ Provide mechanisms and facilitates for enabling the public and communities to participate in managing the water resources within each catchment area.

d) Catchment area advisory committee

In Section 16 of the Act, there states that the Authority, in consultation with the Minister, shall appoint a committee of not more than 15 members in respect of each catchment area. The Catchment area advisory committee shall, in relation to the catchment for which it is appointed, advise officers of the Authority at the appropriate regional office concerning:-

- ✓ Water resources conservation, use and apportionment;
- ✓ The grant, adjustment, cancellation or variation of any permit; and
- ✓ Any other matters pertinent to the proper management of water resources.
- ✓ The members of the catchment area advisory committee shall be chosen from among:-
- ✓ Representatives of Ministries or public bodies responsible for matters relating to water resources in the catchment area;
- ✓ Representatives of any regional development authorities and local authorities whose areas of jurisdiction or any part thereof fall within the catchment area concerned;
- ✓ Representatives of farmers of pastoralists within the catchment area concerned;
- ✓ Representatives of the business community operating within the catchment area concerned;
- ✓ Representatives of the Non-Governmental Organizations engaged in water resources management programmes within the catchment area concerned; and
- ✓ Other persons who have demonstrated competence in matters relating to the management of water resources.

National Monitoring of and information on water resources management

The National water resources management strategy shall provide for national monitoring and information systems on water resources.

The system shall provide for-

- The collection and management of Data and information regarding water resources and the management; and
- Procedures for gathering data and the analysis and dissemination of information on water resources.

3..37 Employment Act 2007

General Principal

The Act constitutes minimum terms and conditions of employment of an employee and any agreement to relinquish vary or amend the terms set shall be null and void.

The act stipulates that no person shall use or assist any other person, in using forced labour. Clause 5 of the act states that its shall be the duty of the Minister, Labour officer, the National Labour Court and the subordinate labour courts to; Promote equality of opportunity in employment in order to eliminate discrimination in employment Promote and guarantee equality of opportunity for a person who, is a migrant worker or a member of the family of the migrant worker lawfully within Kenya

No employer shall discriminate directly or indirectly, against an employee or prospective employee or harass an employee or prospective employee on the following grounds; race, colour, sex, language, religion, political or other opinion, nationality, ethnic or social origin, disability, pregnancy, mental status or HIV status. An employer shall pay his employees equal remuneration for work of equal value

Part IV Rights and duties of employment

The provisions of this part and part VI constitute basic minimum and conditions of contract of service.
The employer shall regulate the hours of work of each employee in accordance with provisions of this Act and any other written law. Subsection (2) of section 27 states that an employee shall be entitles to at least one rest day in every period of seven days. An employee shall be entitles to not less that twentyone working

days of leave after every twelve consecutive months. Section 29 of the Act stipulates that a female employee shall be entitled to three months maternity leave with full pay. Subsection 8 of section 29 further states that no female employee shall sacrifice her annual leave entitlement on account of having taken her maternity leave. *Section 37 (conversion of casual employment to term contract)* Where a casual employee works for a period or a number of continuous working days which amount in the aggregate to the equivalent of not less than one month; or performs work which cannot reasonably be expected to be completed within a period, or a number of working days amounting in the aggregate to the equivalent of three months or more. The contract of service of the casual employee shall be deemed to be one where wages are paid monthly. In calculating wages and the continuous working days, a casual employee shall be deemed to be entitled to one paid rest day after a continuous six days working period and such rest day or public holiday which falls during the period under consideration shall be counted as part of continuous working days.

3.3.8 Work Injuries Benefits Act 2007

Obligations of Employers

Section 7 of the Act stipulates that every employer shall obtain and maintain an insurance policy, with an insurer approved by the Minister in respect of any liability that the employer may incur under this Act to any of his employees.

Registration of employer

Every employer carrying on business in Kenya shall within the prescribed period and in the prescribed manner register with the Director of Occupational Health and Safety Services and any other information as the Director may require.

Subsection 4 of section 8 of the Act states that where an employer carries on business in more than one workplace, or carries on more than one class of business, the Director may require the employer to register separately in respect of each place or class of business.

Employer to keep record (Section 9)

Section 9 states that an employer shall; Keep a register or other record of the earnings and other prescribed particulars of all employees and produce the same on demand by the director for inspection.
Such records shall be retained for at least six years after the date of last entry.

Right to compensation

An employee who is involved in an accident resulting in the employee‘s disablement or death is subject to the provisions of this Act, and entitled to the benefits provided for under the Act. Subsection 3 of section 10 of the ACT however states that no employee shall be entitled to compensation if an accident, not resulting in serious disablement or death, is caused by the deliberate and wilful misconduct of the employee. Section 12 of the act stipulates that if an employee is injured in an occupational accident or contracts an occupational disease while the employee, with the consent of the employer. is engaged in any organized first aid, ambulance or rescue work, or fire fighting or other emergency services, the accident or disease is for the purpose of this Act, deemed to have arisen out of an in the course of the employee‘s employment

Reporting of accidents

A written or verbal notice of any accident shall be given by or on behalf of the employee concerned to the employer and a copy to the Director of occupational health and Safety within twenty-four hours of its occurrence in case of fatal accident.

Lapse of right to benefits

A right to benefits in accordance with this Act shall lapse if the accident is not reported to the employer within twelve months after the date of such accident. However, it shall not be bar to compensation if it is proved that the employer had knowledge of the accident from any other source. Section 30 of the Act states that compensation for permanent disablement shall be calculated on the basis of ninety six months earnings subject to the minimum and maximum amounts determined by the minister after consultation with the board. In case of a fatal accident compensation shall be paid to the dependants of the employee in accordance with the set provisions in the third schedule. The employer shall further be liable to pay reasonable expenses for the funeral of the deceased employee subject to the maximum

amount determined by the minister, after consultation with the National council for occupational Health and Safety

The First Schedule of the Act gives the minimum degree of Disablement for various body parts while the second Schedule gives a list of work description and the associated occupational disease.

3.3.9 Labour Institutions Act 2007

The Act establishes the National Labour Board whose functions shall be to advice the minister on;

- All matters concerning employment and labour
- Legislation affecting employment and labour
- Any matter relating to labour relations and trade unionism
- Labour inspection service
- Reported strikes and lockouts
- Labour facility information and indices etc.
- The board shall in consultation with the minister, establish;
- Work permit committee
- National manpower development committee
- Trade dispute committee
- Productivity committee and such other committees or panel as are necessary for the performance of board‘s functions.

Section 34 of the act stipulates that an authorized officer may either alone or in the presence of another person, enter any premises or place where persons are, or may be employed for the purpose of performing his duties as specified under the Act.

The labour officer may, for the purpose of monitoring or enforcing compliance with any law require the production of wages sheets or other employment records kept by an employer, enter inspect and examine all latrines and other sanitary arrangements or water supply, inspect and examine all food provided or appearing to be provided for employees, and take samples thereof in duplicate, in the presence of the employer or the employers representative which samples shall be sealed and one

sample so sealed shall be left with the employer, order that all buildings and premises where employees are housed or employed be kept in a clean and sanitary condition.

Section 37 of the act states that the medical officer shall exercise the powers conferred upon the labour officer and in addition;

- Order an employee who, in his opinion is sick and for whom the conditions prevailing at the place of employment are not conducive to rapid recovery of his health to proceed to hospital and in that case the employer shall at the earliest opportunity and at his own expense send the employee to the place of work or to a hospital, as the case may be.
- Condemn any food provided for employees which, in the opinion of the medical officer, is unfit for human consumption, and all food so condemned shall be destroyed forthwith in the presence of the medical officer.
- Order at the expense of the employer, such variety of food for an employee as he may deem necessary
- Inspect all drugs and medicine provided for the use of employees

3.3.10 The Occupational Safety And Health Act 2007

Part II – General Duties of the Occupiers

In Section 6 (1), it is stated that the occupier shall ensure the safety, health and welfare at work of all persons working in his work place.

Without prejudice to the generality of an occupier‘s duty under sub section 1 above, the duties of the occupier includes:-

- The provision and maintenance of plant and systems and procedures of work that are safe and without risk to health;
- Arrangements for ensuring safety and absence of risks to health and connection with the use, handling, storage and transport of articles and substances;

- The provision of such information, instruction, training and supervision as is necessary to ensure the safety and health at work of every person employed;
- The maintenance of any workplace under the occupier‘s control, in a condition that is safe and without risks to health and the provision and maintenance of means of access to and egress from it that are safe and without such risks to health;
- The provision and maintenance of a working environment for every person employed that is, safe, without risks to health, and adequate as regards facilities and arrangements for the employees welfare at work;
- Inform all persons employed of:-○Any risks from new technologies; and ○Imminent danger; and
- Ensuring that every person employed participates in the application and review of safety and health measures.

Every occupier shall carry appropriate risk assessments in relation to the safety and health of persons employed and adopt preventive and protective measures to ensure that under all conditions of their intended use without risk to health and comply with the requirements of safety and health provisions.

The occupier shall send a copy of a report of Risk Assessment carried out under this section to the area occupational safety and health officer and shall take (occupier) immediate steps to stop any operation or activity where there is an imminent and serious danger to safety and health and to evacuate all persons employed as appropriate.

Duty to prepare a safety and health policy statement

In Section 7 (1) (a) and (b), it is established that except in such cases that as may be prescribed, it is the duty of every occupier to:-

- Prepare and, as often as may be appropriate, revise a written statement of his general policy with respect to the safety and health at work of his employees and the organization and arrangements for the time being in force for carrying out that policy; and
- To bring the statement and any revision of it to the notice of all of his employees.

Discrimination against employee

Sub section (1) of Section (8) states that the occupier shall not dismiss an employee, injure the employee or discriminate against or disadvantage an employee in respect of the employee‘s employment, or alter the employee‘s position to the detriment of the employee by reason only that the employee:-

- Makes a complaint about a matter which employee considers is not safe or is a risk to his health;
- Is a member of a safety and health committee established pursuant to this Act; or Exercises any of his functions as a member of the safety and health committee.

Safety and Health Committee

Section (9) (1) Illustrates that an occupier shall establish a safety and health committee at the workplace in accordance with the regulations prescribed by the Minister if:-

○There are twenty or more persons employed at the workplace; or ○The Director directs the establishment of such a committee at any other workplace.

Duty not to charge employees for things done or provided

Section (10) (1) states that an Employer shall not make any deduction from an employee‘s remuneration or levy, or permit to be levied on any of his employees any charge in respect of anything done or provided in pursuance of this Act or any regulation made there under.

Safety and Health Audits

Section 11 (1) of the Occupational Safety and Health Act 2007 outlines that the occupier of a workplace shall cause a thorough safety and health audit of his workplace to be carried out at least once in every period of twelve months by a safety and health advisor, who shall issue a report of such an audit containing the prescribed particulars to the occupier on payment of a prescribed fee and shall send

a copy of the report to the Director. The Audit report referred above shall be preserved and be kept available for inspection by the Occupational Safety and Health Officer.

Duties of Self Employed person

Every self-employed person shall:-

- Take all the necessary precautions to ensure his own safety and health and that of any other person in his workplace or within the environs of his workplace;
- All times use appropriate systems of work, preventive and control measures and where not feasible, use suitable personal protective appliances and clothing required under this Act;
- Comply with any safety and health rules, regulations instructions and procedures issued under this Act;
- Report to the Director:-
  - Any situation which he has reason to believe would present imminent danger or hazard and which he cannot correct, and
  - Any incident or injury that arises in the course of or in connection with his works, as required under this Act.

Duties of Employee

Every employee shall, while at workplace:-

- Ensure his own safety and health and that of other persons who may be affected by his Acts or omissions;

Co-operate with his employer or any other person in the discharge of any duty or requirement imposed on the employer or that other person by this Act or any regulation made hereunder;

- At all times wear or use any protective equipment or clothing provided by the employer for the purpose of preventing risks to his safety and health;

- Comply with the safety and health procedures, requirements and instructions given by a person having authority over him for his own or any other person‘s safety;
- Report to the supervisor, any situation which he has reason to believe would present a hazard and which he cannot correct;
- Report to his supervisor any accident or injury that arises in the course of or in connection with his work; and
- With regard to any duty or requirement imposed on his employer or any other relevant statutory provision, co-operate with the employer or other person to enable that or requirement to be performed or compiled with.

Notice of accidents and dangerous occurrences

Section 21(1) Stipulates that; an employer or self-employed person shall notify the area Occupational Safety and Health Officer of any accident, dangerous occurrence, or occupational poisoning which has occurred at the work place.

Where an accident in a workplace, causes the death of a person therein, the employer or self-employed person shall:-

- Inform the area occupational safety and health officer within twenty-four hours of the occurrence of the accident; and
- Send a written notice of the accident in the prescribed form to the area occupational safety and health officer, within seven days of the occurrence of the accident.
- Where an accident in the workplace cause non-fatal injuries to a person therein, the employer shall send to the area occupational safety and health officer, a written notice of the accident in the prescribed form within seven days of the occurrence of the accident; and
- In case of death due to a workplace accident, non-fatal injuries arising from a workplace accident, an occupational disease or a dangerous occurrence at the workplace, involving a selfemployed person incapable of submitting notification, such notification shall be submitted to the area occupational safety and health officer.

Health - General Provisions

Under Section 47 (1) It is established that Every workplace shall be kept in a clean state and free from effluvia arising from any drain, sanitary convenience or nuisance, and, without prejudice to the generality of sub section (1):-

- Accumulations of dirt and refuse shall be removed daily by a suitable method from the floors and benches of workrooms, and from a staircases and passages;
- The floor of every workroom shall be cleaned at least once in every week by washing or, if it is effective and suitable, by sweeping or by any other method;
- All inside walls and partitions, and all ceilings or tops of rooms, and all walls, sides and tops of passages and staircase, shall:-
    - ✓ Where they have a smooth impervious surface, at least once in every period of twelve months, be washed with hot water and soap or cleaned other suitable method;
    - ✓ Where they are kept painted with oil paint or varnished, be repainted or varnished at least once in every period of five years, or such other period as the director may deem necessary, and at least once in every period of twelve months be washed with hot water and soap or cleaned by other suitable method; and
    - ✓ In other cases, be kept whitewashed or colour washed and the white washing or colour washing shall be repeated at least once in very period of twelve months.

After the completion of the proposed project so many local people will be absorbed and employed. Foreigners will also visit the place and they will be from different parts of the country and outside the country. As required by the law the employer shall comply with the Occupational Safety and Health Act 2007.

3.3.11 The Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit sharing) Regulations

The Environmental Management and Coordination *Conservation of Biological Diversity and Resources, Access to Genetic Resources and Benefit sharing Regulations – 2006* regulation applies to conservation of biodiversity which includes conservation of threatened species, inventory and monitoring of biodiversity and protection of environmentally significant areas,

access to genetic resources, benefit sharing and offences and penalties. As per this Act *"no person shall engage in any activity that may have an adverse impact on any ecosystem; may lead to the introduction of any exotic species or to unsustainable use of natural resources, without an Environmental Impact Assessment License issued by the Authority under the Act".*

3.3.12 The Environmental Management and Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations 2009

The Environmental Management and Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations 2009ensures the conservation and sustainable use of wetlands, river banks, lake shores and sea shore. This regulation provides guidelines on management of these areas. This regulation also provides precautionary principal when working near wetlands in order to conserve them.

3.3.13 The Environmental (Impact Assessment and Audit) Regulations 2003

The *Environmental Impact Assessment and Audit Regulations, 2003* provide guidelines for conducting an EIA as well as environmental auditing and monitoring. The Regulations state in Regulation 3 that *"the Regulations shouldapply to all policies, plans, programmes, projects and activities specified in Part IIIand V of the Regulations"* basically lists the guidelines of undertaking, submission and approval of the EIA/ESIA/SEA Report.

3.3.14 The Land Act 2012

The Land Act 2012 is ―an Act of Parliament to give effect to Article 68 of the Constitution, to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land based resources, and for connected purposes‖. Part I of the act is preliminary provisions, part II of the act deals with management of public land, part III of the act deals with administration of public land (Leases, Licenses and Agreements), part IV of the act deals with community land, part V of the act deals with administration and management of private land, part VI of the act deals with general provisions of leases, part VII of the act deals with general provisions of charges, part VIII of the act deals

with compulsory acquisition of interests in land, part IX of the act deals with settlement programmes, part X of the act deals with easements and analogous rights, part XI of the act deals with miscellaneous, the schedule lists repealed laws i.e. The Wayleaves Act, Cap. 292 and The Land Acquisition Act, Cap. 295.

3.3.15The Energy Act 2006

An act of parliament to amend and consolidate the law relating to energy, to provide for the establishment, powers and functions of the energy regulatory commission and the rural electrification authority, and for connected purposes enacted by the parliament of Kenya

―*Biomass*‖ means non-fossilized and biodegradable organic material originating from plants, animals and micro-organism and includes bio-ethanol, bio-diesel, biogas, charcoal, fuel wood and agro waste;

―*energy*‖ means any source of electrical, mechanical, hydraulic, pneumatic, chemical, nuclear, or thermal power for any use; and includes electricity, petroleum and other fossil fuels, geothermal steam, biomass and all its derivatives, municipal waste, solar, wind and tidal wave power;

―*Energy conservation*‖ means the efficient, economic and cost effective production and use of energy; ―*electrical energy*‖ means energy involving the use of electric current which may be produced either by mechanical, chemical, photovoltaic or any other means;

"*petroleum*" includes petroleum crude natural gas and any liquid or gas made from petroleum crude, natural gas, coal, schist, shale, peat or any other bituminous substance or from any product of petroleum crude, natural gas and includes condensate;

Energy regulatory commission

There is established a Commission to be known as the Energy Regulatory Commission whose objectives and functions shall be to–

a) regulate–
    i. importation, exportation, generation, transmission, distribution, supply and use of electrical energy;
    ii. importation, exportation, transportation, refining, storage and sale of petroleum and petroleum products;
    iii. production, distribution, supply and use of renewable and other forms of energy;
    iv. Protect the interests of consumer, investor and other stakeholder interests.
    v. maintain a list of accredited energy auditors as may be prescribed;
    vi. monitor, ensure implementation of, and the observance of the principles of fair competition in the energy sector, in coordination with other statutory authorities;
    vii. provide such information and statistics to the Minister as he may from time to time require; and
    viii. collect and maintain energy data;
    ix. prepare indicative national energy plan;
b) perform any other function that is incidental or consequential to its functions under this Act or any other written law

Electrical Energy

Subject to the provisions of this Act, a license or

a) generation, importation or exportation, transmission or distribution of electrical energy; or
b) supply of electrical energy to consumers: is provided that for undertakings involving a capacity not exceeding 3,000 kW, the provisions of subsections (2), (3) and (4) shall apply.

Any undertaking operating pursuant to a permit granted under this Act shall–

i. in any case where conveyance of electrical energy to or from any transmission or distribution network is possible, meet the minimum requirements of the owner or operator of the transmission or distribution network as approved by the Commission, and the owner or

operator of any such undertaking shall inform the network owner or operator of all connected load and generation equipment that might have material effect on the network; and

ii. be subject to such conditions as may be specified by the Commission.

The Commission may suspend or revoke a license or permit where–

(a) the undertaking or the execution of the works related thereto has not commenced at the expiry of twenty-four months from the date on which the license or permit was granted, or at the expiry of any extended period which the Commission may allow;

(b) it is satisfied that the license or permit holder is either wilfully or negligently not operating in accordance with the terms and conditions of the license or permit, or the provisions of this Act or any regulations thereunder;

(c) the licensee or permit holder is adjudged bankrupt; or

(d) the licensee or permit holder, at any time after

Commencement of the license or permit, makes representation to the Commission that the undertaking cannot be carried on with profit, and ought to be abandoned, and, upon inquiry the Commission is satisfied that the representation is true.

Petroleum

Under this form of energy:-

- ✓ Aperson shall not conduct a business of petroleum business, importation, refining, exportation, wholesale, retail, storage or transportation of petroleum, except under and in accordance with the terms and conditions of a valid license.
- ✓ A licensee shall not sell petroleum to a person for the purpose of exportation or for resale in Kenya unless that person has a valid exporters or retail license under this Act.
- ✓ A person shall not use a vehicle for the purpose of transporting petroleum unless there is in force, in respect of that vehicle, a valid petroleum permit issued under this Act.

- ✓ No person shall drive a vehicle, or engage a driver, for the purpose of transporting petroleum unless such driver is certified for that purpose in accordance with this Act.

The Commission may, in accordance with section 23 appoint competent and impartial persons to be licensing agents for the purpose of issuing licenses under this Act.

Any person desirous of obtaining a license under this Act shall make an application to the Commission or licensing agent in the manner prescribed by the Commission, and the Commission or licensing agent may, within thirty days–

- ✓ Grant a license accordingly, either without conditions or subject to such conditions as the commission may deem fit and shall be accompanied by the prescribed fee.
- ✓ Refuse to grant such license.

Subject to the provisions of this Act, a person may make an application in the prescribed manner for amendment of the license, and the Commission or the licensing agent may, upon payment of the prescribed fee, amend the license and endorse it accordingly.

Where the Commission or the licensing agent refuses to amend a license under subsection (1), the Commission or licensing agent shall give to the applicant, if the applicant so requests, the reasons in writing for the refusal.

A license amended under this section shall retain the existing expiry date.

Renewable Energy, Energy Efficiency and Conservation

a) The Minister shall promote the development and use of renewable energy technologies, including but not limited to biomass, biodiesel, bioethanol, charcoal, fuel wood, solar, wind, tidal waves, hydropower, biogas and municipal waste.
b) The Minister may perform such functions and exercise such powers as may be necessary under this Act to promote the development and use of renewable energy, including but not limited to–

- ✓ formulating a national strategy for coordinating research in renewable energy;
- ✓ providing an enabling framework for the efficient and sustainable production, distribution and marketing of biomass, solar, wind, small hydros, municipal waste, geothermal and charcoal;
- ✓ promoting the use of fast maturing trees for energy production including biofuels and the establishment of commercial woodlots including peri-urban plantations;
- ✓ promoting the use of municipal waste for energy production, and
- ✓ promoting the development of appropriate local capacity for the manufacture, installation, maintenance and operation of basic renewable technologies such as biodigesters, solar systems and hydro turbines;
- ✓ promoting international co-operation on programmes focusing on renewable energy sources;
- ✓ harnessing opportunities offered under clean development mechanism and other mechanisms including, but not limited to, carbon credit trading to promote the development and exploitation of renewable energy sources;
- ✓ promoting the utilization of renewable energy sources for either power generation or transportation;
- ✓ promoting co-generation of electric power by sugar millers and sale of such electric power through the national grid directly to the consumers;
- ✓ Promoting the production and use of gasohol and biodiesel.

The Minister may perform such functions and exercise such powers as may be necessary under this Act to enhance energy efficiency and conservation, including but not limited to–

- ✓ making, in consultation with the Kenya Bureau of Standards, requirements for the particulars to be displayed on labels on equipment or on appliances;
- ✓ taking all measures necessary to create awareness and for the dissemination of information for efficient use of energy and its conservation;
- ✓ strengthening consultancy services in the field of energy conservation;
- ✓ promoting research and development in the field of energy conservation;
- ✓ formulating and facilitating implementation of pilot projects and demonstration projects for promotion of efficient use of energy and its conservation;

- ✓ giving financial assistance to institutions for promoting efficient use of energy and its conservation;
- ✓ supporting the preparation of educational curriculum on efficient use of energy and its conservation for educational institutions, and coordinate with them for inclusion of such curriculum in their syllabus;
- ✓ implementing international co-operation programmes relating to efficient use of energy and its conservation; and
- ✓ giving financial incentives for any investment made to replace or install additional capital investments to improve energy efficiency; **The Energy Tribunal**

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under this Act, the provision is made for appeals from the decisions of the Commission, all such appeals shall be made to the Energy Tribunal, in accordance with the provisions of this Part.

. For the purpose of hearing and determining appeals in accordance with section 107 and of exercising the other powers conferred on it by this Act, there is established a tribunal to be known as the Energy Tribunal, hereinafter referred to as the ―Tribunal‖.

The members of the Tribunal shall be appointed from among persons with a university degree and not less than fifteen years relevant experience in matters related to electricity, petroleum, finance, economics, engineering, energy or law and shall consist of–

a) a Chairperson and vice Chairperson appointed by the President, in consultation with the Judicial Service Commission from among persons qualified to be judges of the High Court;
b) three other members who are persons possessing, in the opinion of the Minister, expert knowledge of the matters likely to come before the Tribunal and who are not in the employment of the Government or any state corporation; and
c) the members under paragraph (b) shall be appointed by the Minister in consultation with the Attorney General. A member of the Tribunal shall hold office for appointment for a

period of three years and shall be eligible for re-appointment for one further term of three years.

A member of the Tribunal shall hold office on such terms and conditions as shall be prescribed in the instrument of appointment.

The provisions set out in the Third Schedule shall have effect in relation to the membership and conduct of business and affairs of the Tribunal.

Miscellaneous Provisions

- ✓ The Minister may, on the recommendation of the Commission and subject to sections 63 and 102, make regulations for or with respect to any matter that by this Act is required or permitted to be prescribed, or that is necessary or expedient to be prescribed for carrying out or giving effect to this Act.
- ✓ The regulations to be made under this Act may be made by the Commission on its own motion or may be proposed to the Commission by any licensee or person.
- ✓ Before making recommendation of any regulations to the Minister under this Act, the Commission shall publish the proposed regulations for purposes of inviting proposals from the public, in such manner as it may deem fit, at least forty days before the regulations are submitted to the Minister.
- ✓ The regulations made by the Minister in accordance with this section may, impose conditions, requiring acts or things to be performed or done to the satisfaction of the Commission, prohibiting acts or things from being performed or done and may prescribe periods or dates upon, within or before which such acts or things shall be performed or done or within which such conditions shall be fulfilled.
- ✓ The regulations made under this Act may be made for a limited period or without limit of period, and may be made subject to such conditions as the Minister deems fit, and may contain such supplemental and consequential provisions as the Minister considers necessary for giving full effect to the regulations.

- ✓ No person shall use or employ for or in connection with any of the purposes of producing, generating, transforming, transmitting, distributing, supplying, or importing, exporting, transporting, refining, storing, selling or using, any form of energy, any mode, material or apparatus other than that which complies with the specification or standard of the Kenya Bureau of Standards or where no such standard exists, any international standard approved by the Kenya Bureau of Standards.

- ✓ While discharging its functions and exercising its powers under the Act, the Commission shall ensure that no particular person is given undue preference or subjected to any undue disadvantage.

- ✓ All persons engaged in any undertaking or activity pursuant to a license or permit under this Act shall notify the Commission in writing, in the form and manner prescribed by the Commission, of any accident or incident causing loss of life, personal injury, explosion, oil spill, fire or any other accident or incident causing significant harm or damage to the environment or property which has arisen in Kenya or within Kenya‘s Exclusive Economic Zone or Outer Continental Shelf.

- ✓ The Commission may direct an investigation to be carried out into any accident or incident under subsection (1) and take such action as it deems necessary.

3.3.16 National Construction Authority Act No. 41 of 2011

This is an Act of Parliament to provide for the establishment, powers and functions of the National Construction Authority and for connected purposes.

The Act defines ―construction works‖ as the construction, extension, installation, repair, maintenance, renewal, removal, renovation, alteration, dismantling, or demolition of:-

a) Any building, erection, edifice, structure, wall, fence or chimney, whether constructed wholly or partly above or below ground level;
b) Any road, harbour works, railway, cableway, canal or aerodrome;
c) Any drainage, irrigation or river control works;
d) Any electrical, mechanical, water, gas, petrochemical or telecommunication works; or

e) Any bridge, via-duct, dam, reservoir, earthworks, pipeline, sewer, aque-duct, culvert, drive, shaft, tunnel or reclamation works, and includes any works which form an integral part of, or are preparatory to or temporary for the works described in paragraphs (a) to (e), including site clearance, soil investigation and improvement, earth-moving, excavation, laying of foundation, site restoration and landscaping.

The Act establishes the National Construction Authority which among its functions include to oversee the construction industry and coordinate its development. The National Construction Authority (N.C.A) is mandated to streamline, overhaul and regulate the construction industry in Kenya and establish a code of conduct for the industry.

Among the powers of the Authority include; with the approval of the Minister, to facilitate, or promote the establishment or expansion of, companies, corporations or other bodies to carry on any activities related to construction either under the control or partial control of the Authority or independently.

The Act states the conditions required for one to be registered to trade as a contractor in the country, whether a local or a foreigner. It defines a contactor as;

A person who carries on business as a contractor where such person, for reward or other valuable consideration, undertakes the construction, installation or erection, for any other person, of any structure situated below, on or above the ground, or other work connected therewith, or the execution, for any other person, of any alteration or otherwise to any structure or other work connected therewith, and undertakes to supply:-

a) The materials necessary for the work, or is authorized to exercise control over the type, quality or use of the materials supplied by any other person;
b) The labour necessary for the work, or is authorized on behalf of the person for whom the work is undertaken or any other person, to employ or select workmen for employment for the purposes of the execution of the work, whether under a contract of service or otherwise.

3.3.17 The Environmental Management and Co-Ordination (Amendment) Act, 2015

This is an Act of Parliament to amend the Environmental Management and Co-ordination Act, 1999. The interpretations for the following terms are redefined; "coastal zone", "exclusive

economic zone", "natural resources", "wetland". The terms "District Environment Committee"; and "District Environment Action Plan" have been entirely deleted.

The following terms have been (in a proper alphabetical order) inserted; "Cabinet Secretary", "continental shelf‖, "County Environment action plan", "County Environment Committee", "County Government", "Environmental Organization", "Indigenous knowledge‖, "Ministry", ―natural resource agreements", "person", "Strategic Environmental Assessment", "traditional knowledge‖, ―Voluntary Environmental Management‖, "wildlife".

The principal Act is amended by deleting the words in the first column and substituting therefore the words in the second column wherever they appear in the Act-

First Column

Minister

Chairman

Complaints Committee

District

District Environment Committee

High Court

Permanent Secretaries

Non-Governmental organizations

Second Column

Cabinet Secretary

Chairperson

Department

County

County Environment Committee

Environment and Land Court

Principal Secretaries

Public benefit organizations

A new subsection is inserted immediately after subsection (2) of section 2 of the Act, which states; "Every person shall cooperate with state organs to protect and conserve the environment and to ensure the ecological sustainable development and use of natural resources".

The principal Act is amended by inserting a new section immediately after section 3, which about Access to information and states that;

1) Subject to the law relating to access to information, every person has the right to access any information that relates to the implementation of this Act that is in the possession of the Authority, lead agencies or any other person.
2) A person desiring the information referred to in subsection (1) shall apply to the Authority or a lead agency and may be granted access to such information on payment of the prescribed fee.

The principal Act is amended by repealing section 4 which was on the Establishment of the National Environment Council. The principal Act is amended by repealing section 6 which was on the Procedure of the Council. The principal Act is amended by repealing section 8 and replacing it with a new section which states; ―The headquarters of the Authority shall be in Nairobi but the Authority shall ensure its services are accessible in all parts of the Republic‖.

The principal Act is amended by repealing section 29 which was on Provincial and District Environment Committees and replacing it with a new section on County Environmental Committee.

The principal Act is amended by repealing section 30 that was about the Functions of Provincial and District Environment Committees, and replacing it with a new section on Functions of the County Environment Committee.

The principal Act is amended by repealing section 3l which was about Public Complaints Committees and replacing it with a new section on National Environmental Action Plan.

The principal Act is amended by repealing section 39 which was on Provincial Environment Action Plans.

The principal Act is amended by repealing section 40 which was about District Environment Action Plans and replacing it with a new section on County environment action plan.

The principal Act is amended by repealing section 4l which was about Contents of Provincial and District Environment Action Plans and replacing it with a new section on the contents of county environment action.

The following new sections have been inserted immediately after section 41; ―Purpose of Environmental Action Plans‖, ―Monitoring, Compliance and Environmental Plans‖.

The principal Act is amended by inserting a new section immediately after section 56 about ―Guidelines on Climate Change‖.

The principal Act is amended by inserting a new section immediately after the heading of Part VI on ―Strategic Environmental Assessment‖.

Section 69 of the principal Act on Environmental Monitoring is amended by inserting a new subsection immediately after subsection (l) as follows- Every lead agency shall establish an environmental unit to implement the provisions of this Act.

Section 70 of the Act that was on ―Establishment of Standards and Enforcement Review Committee‖ is repealed.

The principal Act is amended by repealing section 7l that was about ―Functions of Standards and Enforcement Review Committee‖ and, replacing it with a new section on ―Water quality standards‖.

The principal Act is amended by repealing section 78 on ―Air quality standards‖ and replacing it with a new section.

The principal Act is amended by repealing section 101 on ―Standards for noise‖ and replacing it with a new section.

The principal Act is amended by inserting a new section on ―County Legislation‖ immediately after section 147, which states that; ―A County may make legislation in respect

of all such matters as are necessary or desirable that are required or permitted under the Constitution and this Act‖.

The principal Act is amended by repealing section 148 which was on Existing laws relative to the environment and replacing it with a section on ―Effect of existing Laws‖.

The principal Act is amended by repealing the Second Schedule and substituting therefore a new Schedule altogether.

3.3.18 The Environmental Management and Co-Ordination (Air Quality) Regulations, 2014

These regulations apply to:-

a) all internal combustion engines,
b) all premises, places, processes, operations, or works to which the provisions of the Act and Regulations made thereunder apply, and
c) Any other appliance or activity that the Minister may by order in the Gazette, specify.

The fourteenth schedule to the regulations lists Portland cement plants (clinker plants included) among controlled facilities where these regulations apply. Part VIII of the Fifth schedule to these regulations gives Guidelines on sources of fugitive emission air pollutants. The following are listed as the sources of fugitive emissions:

a) construction activities;
b) storage and handling, including loading and unloading, of materials such as bauxite, alumina, gypsum, or Portland cement or the raw materials therefore;
c) mining and quarrying activities;
d) haul roads;
e) haul trucks;
f) tailings piles and ponds;
g) demolition activities;
h) blasting activities; and
i) Sandblasting operations.
j) wind breaks; and
k) The paving of roads.

l) conveyor belts

3.4 The Feed- In-Tariff Policy

In a bid to attract private investment into the renewable energy sector, the Government issued a policy on renewable energy feed-in-tariffs. The Feed-in-Tariffs Policy for wind, biomass and small hydro was published in March 2008 following approval by the Public Procurement Oversight Authority. The 2008 FiT Policy covered wind, small hydro and biomass sources, for plants with capacities not exceeding 50 MW, 10 MW, and 40 MW respectively. However, the FiT Policy has been reviewed twice, the latest being in December 2012. The review has been done prudently so as not to negatively affect the economic growth and social wellbeing.

A feed-in-tariff as described in the policy is an instrument that allows power producers to sell renewable energy-generated electricity to an off-taker (the buyer of electrical energy for the purpose of selling the electricity to customers connected to the national or mini-grid systems) at a pre-determined tariff for a given period of time. Renewable energy sources in Kenya include wind power, biomass, small hydro, solar, biogas and geothermal.

The objectives of the FiTs system are to:

- ✓ Facilitate resource mobilization by providing investment security and market stability for investors in electricity generation from renewable energy sources;
- ✓ Reduce transaction and administrative costs and delays associated with the conventional procurement processes;
- ✓ Encourage private investors to operate their power plants prudently and efficiently so as to maximize returns.

The policy provides that small renewable energy projects with a capacity of up to 10 MW shall have a standardized power purchase agreement which shall incorporate certain features such as no bidding for renewable sites and resources. Feed-in-tariff values for small renewable projects are provided in the policy which further outlines principles that underline the calculation of the said values which include as stated in Section 25, a calculation on a technology specific basis using the principle of cost plus reasonable investor return.

The policy further provides that renewable energy projects which are larger than 10 MW of installed capacity shall meet load flow or dispatch and system stability requirements. The

policy gives the feed-in-tariffs for each of the renewable energy sources it covers and one of the common features is that the feed-in-tariff is to apply for twenty (20) years from the date of the first commissioning of the respective power plants.

The developer is to bear the costs of interconnection including the costs of construction, upgrading of transmission lines, substations and associated equipment. The off-taker is to recover from electricity consumers 70% of the portion of the feed-in tariff, except for solar plants connected to off-grid systems, where the off-taker recovers 85%. Finally, the policy provides that renewable energy generators feeding into the grid will require a power purchase agreement and further that the project sponsor for such renewable generation projects must be an entity legally registered in Kenya.

4. BACKGROUND TO COUNTY

4.1 Administrative, Geographic and Physical Description.

This section provides a description of the County profile, with background formation of administrative boundaries, physiographic and natural conditions, settlement patterns and other background information that are critical. All the information in this section was sourced from the former District Development Plans.

4.1.1 Position and size of the County

County is located in the Coast Province of Kenya. It covers a total surface area of 12,610 km² and accounts for 2.17 per cent of Kenya's total surface area. It is located South west of Mombasa on coordinates 4^0 10' 28"S and 39^0 27' 37" E

4.1.2 Administrative and Political Units in KWALE County

The county has 4 sub counties namely, Matuga, Msambweni, LungaLungaand Kinango where the proposed site falls.

4.2 Settlement patterns

Human settlement in the County is influenced by urbanization, industrial development, climatic conditions and soils, accessibility to water points which are linked to the livelihood zones, namely; Fishing and Sand Harvesting, Forestry and Tourism, Mixed Farming, Ranching, Salt Works and Urban Zone.

4.3 Major Towns in County

The County's capital is the coastal town of which is an inland. The main ethnic group are the Digo and duruma and also Kamba

4.4 Geography and climate

The topography of the County is dominated by alluvial deposits , and a terrain that generally slopes towards the sea. County has has the famous Shimba hills national reserve and Mwaluganje elephant sanctuary.The County experience a monsoon climate which is hot and dry. The average annual rainfall ranges from 400mm in the hinterland parts of the County to 1,600mm along the coastal belt.

4.5 The People of KWALE County

. The main communities residing in County include seven Mijikenda sub-groups (Giriama, Digo and Duruma), the Bajuni, Swahili, and people of Arab, Indian and European descent who have permanently settled in the county. There are other Kenyan communities who have also settled in the County because of their employment or for purposes of doing business. Over time, these people have had close interactions with each other, and fostered the Swahili culture and language. Most of the people in County are either Christians or Muslims, though other smaller religious communities exist.

4.5.1 Religion and Traditional Culture

Majority of people living in County are either Muslims or Christians, although the county has several smaller religious communities such as the Africa Indigenous Religion and Hindu.

Kiswahili and Mijikenda language are widely spoken across the county. The Mijikenda (nine cities) is a wider grouping that comprises nine sub-tribes; Giriama, Digo, Chonyi, Kamabe, Jibana, Kauma, Duruma, Rabai and Ribe. All of these sub-groups speak the Mijikenda language.

Traditionally, the Mijikenda believed in a supreme god, Mulungu. The community has a sacred forest - the Kaya - which is used by the elders as a place of prayer to Mulungu. The Kaya forest was enlisted as a World Heritage Site in August 2008.

Mijikenda are small scale farmers mainly growing coconut palm, cassava, cashew nuts, yams, millet and sweet potatoes. They are renowned for their rich folk music tradition that involves rhythmic percussion.

4.6Economy of County

4.6.1 Agriculture and Rural Development

Most farmers in the County are subsistence and most of the purchased inputs are certified seeds. There is limited use of both organic and inorganic fertilizers. Most of the farm holdings are less than a hectare. The County‘s variety of micro-climates makes the area suitable for the production of a variety of crops such as mangoes, cashew nuts, maize, beans, pigeon peas and cow peas. The main livestock enterprises include Dairy Cattle, Beef Cattle, Poultry, Sheep, Goats, Pigs, Rabbits and Bee-keeping. The major potentials which exist in the fisheries sub-sector include mariculture development; exploitation of deep sea fisheries; ice production for fish preservation; acquisition, securing and development of fish landing sites; empowering of fishers to enhance sustainable utilization of fisheries resources. The major activities under cooperatives are savings and credit cooperatives (SACCOs) are fishing cooperatives. Other types of cooperatives include ranches, transport, quarrying and multipurpose.

4.6.2 Potential crops for cultivating in

The average precipitation of 600 mm and mean-annual temperature of 27°C hold potential for agricultural development. Horticultural crops and vegetables such as chillies, brinjals, okra, onions and tomatoes can be cultivated along the Coastal plains. Staples like maize, rice, bananas, cow peas, green grams and beans can also do well. Northwards, along the Sokoke Forest, is land with medium agricultural potential. Further north, are the pineapple fields in that can provide large scale farming. Jatropha, aloe vera and vanilla grow well in the County and could be promoted for the production of bio-diesel, pharmaceuticals, cosmetics and food products.

4.6.3 Trade, Tourism and Industry

Tourism is one of the most important economic activities in the County. The major tourist attractions in the County are historic sites; topography; flora and fauna; water sports and recreation; cultural attractions and agro-tourism.

The industries in the County are manufacturing industries. Most of them are medium and small-scale enterprises. Small-scale Jua Kali cottage industries are also available in the

County. Small-scale manufacturing industries have emerged and they manufacture goods such as Neem Soap and Wood Carvings.

Trading patterns in the County revolve around trading in agro-based goods, raw materials and other products from the manufacturing sector. In the County various types of trade such as retail, wholesale, distribution and hawking are carried out in a very elaborate way. The wholesale businesses are few and are located mainly in the major trading centres such as andMsambweni.

4.6.4 Mining and manufacturing

County is rich in minerals; mainly titanium and iron ore, that have spurred extensive industrial mining activities. Other minerals extracted include barites, galena, rubies, pozzolana, gypsum and limestone. Salt mining and sand harvesting have been carried out over the years to take advantage of the sandy, salty waters. While these are economically lucrative, they are equally responsible for destruction of its mangrove forests. As for manufacturing sector there are

- ✓ Cotton factory
- ✓ Milk processing factory
- ✓ Steel Manufacturing factory (Devki Samburu)

4.6.5 Tourism

Tourism is very important for the County. It creates opportunities for employment in the service industries associated with it, such as transport, entertainment and advertising.

There has been an up-trend in tourism over the last few years and the County is well positioned to benefit from; local tourism, eco-tourism, pro-poor tourism, educational tourism, cultural tourism and sport tourism. All these trends offer opportunities for significant growth of the tourism sector in County.

Main attractions

- ✓ Diani beaches
- ✓ Mwaluganje Elephant Sanctuary
- ✓ Shimba Hills National Reserves.

4.7 Physical Infrastructure

The movement of people for socio-economic and cultural activities depends on good transport and communication system. A good road network provides access to the markets, health and other social facilities and also reduces incidences of insecurity.

The improvement of telephone services has made it easier to communicate within the County and other outside areas. This has improved efficiency in service delivery and decision making. The improvement in the communication system makes the communities who can contribute to their development.

4.7.1Public Amenities

4.7.1.1 Health Facilities

The County has inadequate health facilities especially in the rural areas. Issues concerning mother and child care are not adequately addressed in most rural facilities. The same rural health facilities are also far from the community making them difficult to access. Also as a result of high poverty levels, women are discouraged from visiting facilities due to fee charges.

Has several healthcare facilities both private, missionary and public serving the residents.

Diani Scheme Community health unit

Kinondoni,Ukunda,Mtuwa,Neema

Mvumoni

Biga

Bomani

4.7.1.2 Social Halls

Commonly used in presiding of wedding extensions, business meetings, community meetings and many more. Some of the common halls are;

l

4.7.1.3 Recreational Parks & Stadia

Refreshment of strength and spirits not only meant for recreation but sightseeing too…experience the calm embrace blended with nature, heritage, and culture. These include;

- Mazeras ,Mazingira Park -

4.11Governance, Justice, Law and Order

For any development to take place in the County, maintenance of law and order is very vital. Investors cannot invest in an environment of uncertainty. Therefore, this sector plays a crucial role in availing an enabling environment for investment.

Table 2: Roles of different stakeholders in maintaining Law and order in the County

Stakeholder	Roles
County Government	Provide conducive environment for all players to operate and creating peaceful environment for development.
Police	Maintain Law and order.
Central Bureau of statistics, civil Registration and Registration of persons	Collection of data for planning and decision making process
Private security firms	Supplementing police effort in maintaining security
Law firms	Providing legal services

4.11.1 Public Administration

Public administration plays a crucial role in availing an enabling environment for investment which is achieved through improved security, sound economic and financial management and development oriented administration.

Apart from the County administration, other stakeholders are also involved in matters public administration, these are summarized in the table below:

Table 3: public administration

Stakeholder	Roles
Coast Development Authority and Planning Department	Co-ordination of development activities; providing planning of development projects and programmes services.
Central Bureau of Statistics, Civil Registration and Registration of Persons.	Collection of data for planning and decision making process.
Community	The community plays the role of providing information to the public administrators and initiating planning and implementation of development beside monitoring and evaluation. The community is also involved in community policing.

4.11.2 Special Programmes

Various efforts to enhance the community capacities for self-reliance and greater participation in the development process have been put in place in the County through community mobilizations as well as initiating and supporting community based development programmes targeting women, children, older persons, youth, people living with disabilities, the poor, and other minority groups. This has been done through social grants by the gender and social services department, the youth enterprise fund, community driven development and support to local development components of Arid Lands Resources Management Project.

On cultural and social services, the focus is on training and empowering local communities on participation in implementation of sports activities, preservation of cultural identity and heritage through cultural resources centres as well as carrying out flagship cultural and sports festivals and exhibitions.

The County is prone to disasters such as floods, drought, fires and Tsunami due to the harsh climatic conditions and the location of the County. Gender inequality in the County is deeply rooted in culture and traditions. Through the Youth Fund, Women Fund and other devolved

funds, the youth and women in the County are being made to ensure that they are economically empowered.

4.12 Major Challenges and Cross Cutting Issues in the County

This section provides analysis of the major development challenges and cross cutting issues that are realized within the County. The major challenges that are addressed relate to landlessness which is then followed by analysis of the cross cutting issues including population growth, poverty, HIV/AIDS, disaster and Environmental Conservation & Management.

4.12.1 Landlessness

The available data which was obtained in the District from Welfare and Monitoring Survey 1997 showed that about 11.3% of the households in the County were landless where many of these people were squatters in private land. Although the Government adjudicated several schemes, the number of people settled was below target. Many people have no legal documents for land ownership where people own the land customarily. The absence of title deeds, has discouraged full utilization of land and as well led to low level of investment with no permanent structures in place.

4.12.2 Poverty

According to data contained in the District Poverty Assessment Report-2000, the County had a considerable number of persons considered to be in absolute poverty. This poor are defined as people who are unable to meet basic food and no-food requirements. The poor persons or households in the County are characterized by high disease incidences with high cost of drugs and treatment, food shortage, poor states of dwelling units (Shanties) both in rural and urban areas, over indulgence in consumption of local palm wine and drugs, poor sanitary conditions both in the urban and rural areas and lack of access to clean water. The poverty situation in the County has been exacerbated by the decline in the tourism industry, poor returns from agricultural produce and adverse weather conditions experienced in the recent past.

4.12.3 HIV/AIDS

According to the Ministry of Health, the County‘s HIV/AIDS prevalence rate is between 1517 percent. The high prevalence rate in the County is caused by promiscuity, prostitution, drug addiction, and alcoholism, traditional practices such as wife inheritance, polygamy and belief in witchcraft. This trend has led to increased poverty levels in the County. The major challenges brought about by emergence of HIV/AIDS in the County include increase in number of children in need of special protection. The HIV/AIDS prevalence in the County is estimated at 15% implying that one in every seven adults is infected with the virus.

4.12.4 Gender inequality

Gender concerns in County relate to the place of men and women in society, education, economic activities, land and other property ownership. In the County, women form the bulk subsistence of agricultural labour and are engaged in activities such as growing and marketing farm produce. Other chores include caring for children and other domestic chores. Many women in the County do not own land and other property and therefore cannot use land as collateral to get bank credit. In semi-arid areas such as many parts of Kinango Sub-County, women devote many more hours looking for water.

4.12.5 Water

Semi-Arid areas in the County have acute water problem. Women travel long distances looking for water for domestic use. This takes most of their time which they could have used elsewhere for productive and economic activities. The water quality in most areas is low hence exposing them to diseases.

4. 13 Environmental Conservation and Management

Climate and Physiographic conditions have a great influence on socio-economic activities in County. Poor farming practices, deforestation and settlement patterns have caused great environmental impact in the County. The major adverse environmental impacts include land degradation, deforestation, sea erosion and air pollution, dumping of commercial and domestic waste in town and marine pollution.

4.13.1 Deforestation

Tree felling without replacement in non-gazetted forests have reduced the forest area in the County. These areas have been opened up for agriculture and settlement because they are

viewed as a common resource by the community. The indigenous trees have been exploited for timber, poles and firewood. Such activities have greatly reduced the forest area in the County. The Mangrove forests in the estuaries have also been targeted for firewood, poles, salt and lime burning. These forests are a natural nursery for fish and migratory birds and uncontrolled exploitation is likely to affect the marine life.

4.13.2 Water Pollution

Water pollution within the County is common in Kinango Sub-County where sand harvesting is prevalent. These activities have increased water salinity and erosion.

4.13.3 Soil Erosion and Degradation.

Sloping terrain and poor land use practices in parts of the County have increased vulnerability of these areas to soil erosion. The common practices include, slash and burn and shifting cultivation.

5. BASELINE ENVIRONMENTAL CONDITION OF THE PROPOSED PROJECT SITE

5.1 Introduction

Assessment of impacts on vegetation for the proposed project was be done using

International Finance Corporation‘s guidance note 6 on Biodiversity Conservation and Sustainable Management of living Natural Resources. Specifically, paragraph 7 requires that the risks and impacts identification process to consider direct and indirect project-related impacts on biodiversity and ecosystem services, and identify any significant residual impacts. The assessment considered relevant threats to biodiversity and ecosystem services, focusing on habitat loss, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution. Additionally, the assessment took into account the differing values attached to biodiversity and ecosystem services by affected Communities and other stakeholders.

5.1.1 Methods used in collection of vegetation baseline at the proposed project site

Screening method (walk-throughs) and botanical surveys using plot-less method were used to collect baseline flora data at the proposed project site. Walk-through was conducted prior to project implementation to survey and documents areas of potential biodiversity concern nesting sites, presence of endangered species. Screening is a vitally important tool for predicting and understanding potential biodiversity impacts, as it can help determine whether biodiversity will be a significant issue for a project, and spotlight what issues to monitor and prioritize for future study. The plot-less method developed by Hall and Swaine (1981) and modified by Mwachala, et al. (2004), was used to capture plant diversity at the proposed project site. The survey method involves random walks through the proposed project site. To ensure complete and representative observations, sampling will be stopped after considerable time, usually two hours or when the discovery of unrecorded species is less than one in two minutes. In addition, collections are recorded randomly where possible to cover the edges

and other unique habitats. All the vascular plant species encountered were recorded in each of the habitat and specimens selectively collected in duplicate using standard methods (Foreman &Bridson, 1992). Any encountered difficulty and unique plant species was collected and confirmed at the East African Herbarium and specimens prepared for preservation. Species uniqueness (endemism, rarity, threat i.e. vulnerable, endangered) was determined through literature review, voucher specimens and databases at the East African Herbarium based on LEAP (Knox &Berghe, 1996) as well as using experienced botanical experts. GPS coordinates on areas of biodiversity rich and endangered flora and fauna are found were recorded and mapped to ensure minimum disturbance on such sites.

5.2 Vegetation community at the proposed project site

The proposed project site is dominated by secondary vegetation, weeds and invasive being the dominant community. This was as a result of the area once being a sisal plantation and later left bare for the secondary colonizers to thrive. High species number and endemism were not expressed on the site as there were previous disturbances on the area and there was hardly any relic forest patch in the area. The shore edges are characterized by rocky outcrop with *Canavalia rosea,Capariscartilaginea and Allophylus pervillei*

There were 3 distinct habitats: the secondary vegetation dominated by *Ricinus communis* and *Phyllanthus reticulatus*; the habitat near the shore line dominated by *Mimusopsobtusifolia* and further away from the shore were small patches of indigenous plants with few *Adansonia digitata* and *Cassytha filiformis* growing on *Azidiracta indica.*

5.2.1 Species richness

Seventy sevenspecies were recorded with the grass family Gramineae being the most dominant with species like *Cenchrus cilliaris, Dactylocteniumaegyptium, Urochloatrichopus* and *Digitaria nuda* The Bean family or Leguminosae had species like *Senna didymobotrya, Indigofera tinctoria, Canavalia rosea*

The herbaceous plants were the most dominant life form followed by shrubs and sedges and grasses, trees were very few with the least representation. Species like *Sideroxyloninerme, Capparis cartilaginea*and *Adansonia digitata* are some of the dominant species in the coral rag.

*Ricinus communis*or Castor Bean is a fast growing, evergreen herbaceous or semi-woody large shrub or small tree that reaches 5 meters tall and 4.5 m wide with poisonous seeds due to the presence of ricin protein. Geographically. *Ricinus communis* is native to northeastern Africa and the Middle East. It has escaped cultivation and become naturalized as a weed almost everywhere in the world that has a tropical or subtropical climate. Castor Bean grows wild on rocky hillsides, and in waste places, fallow fields, along road shoulders and at the edges of cultivated lands. *Plectranthusflaccidus, Indigofera tinctoria* were also dominant species.

Indigofera tinctoria is a leguminous plant which is widespread across tropical regions around the globe, as it had been cultivated and highly valued for centuries as a main source of indigo dye, leading to its common names _true indigo‘ and _common indigo‘, before commercial synthetic indigo production came into use .it has the potential to invade native ecosystems and poses both a present and a future threat.

5.2.2 Plant species conservation status

Species Conservation status

The IUCN (International Union for Conservation of Nature) Red List of Threatened Species provides taxonomic, conservation status and distribution information on plants. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those plants and animals that are facing a higher risk of global extinction i.e. those listed as Critically Endangered, Endangered and vulnerable. The IUCN Red List also includes information on plants that are categorized as Extinct or Extinct in the Wild; on taxa that cannot be evaluated because of insufficient information (i.e., are Data Deficient); and on plants that are either close to meeting the threatened thresholds or that would be threatened were it not for an on-going taxon-specific conservation programme

(i.e., are Near Threatened). CITES (Convention on International Trade in Endangered Species) of Wild Fauna and Flora is an international agreement between governments that aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. On the proposed wind power project site all the encountered plant species were under Least Concern (LC) category on the IUCN red list. The table below is a checklist of the plant species encountered during the survey.

Table 4: Checklist of plant species observed at the proposed project site

Family	Genus	Species	author	Life form
Acanthaceae	Hygrophila	auriculata	(Schumach.) Heine	Herb
Acanthaceae	Justicia	gangetica		Herb
Acanthaceae	Thunbergia	alata	Bojer ex Sims	Herb
Amaranthaceae	Achyranthes	aspera	L.	Herb
Amaranthaceae	Psilotrichum	sericeum	(Roxb.) Dalziel	Herb
Amaranthaceae	Aerva	lanata	(L.) Juss	Herb
Amaryllidaceae	Scadoxus	multiflorus	(Martyn)Raf.	Herb
Araceae	Gonatopus	boivinii	(Decne.) Engl.	Herb
Asparagaceae	Asparagus	racemosus	Willd.	Herb
Balanitaceae	Balanites			Shrub
Bombacaceae	Adansonia	digitata	L.	Tree
Burseraceae	Commiphora	edulis	(Klotzsch) Engl.	Shrub
Capparaceae	Capparis	cartilaginea	Decne.	Shrub
Commelinaceae	Commelina	mascsrenica		Herb
Commelinaceae	Commelina	africana	L.	Herb
Compositae	Conyza	sp		Herb
Compositae	Launaea	cornuta	(Hochst. Ex Oliv. &Hiern) C.Jeffre	Herb
Compositae	Vernonia	sp		Herb
Convolvulaceae	Hewittia	sublobata	(L.f.) Kuntze	Herb
Convolvulaceae	Merremia	ampelophylla	Hallier f.	Herb
Cucurbitaceae	Coccinia	grandiflora	Cogn.	Herb
Cucurbitaceae	Momordica	trifoliotata	Hook.f.	Herb
Cyperaceae	Cyperus	rotundus	L.	sedge
Cyperaceae	Cyperus	cyperoides	(L.) Kuntze	sedge
Cyperaceae	Fimbristylis	cymosa	R.Br.	sedge
Euphorbiaceae	Ricinus	communis	L.	Shrub
Euphorbiaceae	Euphorbia	hirta	L.	Herb
Euphorbiaceae	Dalechampia	scandens	L.	Herb
Gramineae	Cenchrus	ciliaris	L.	Grass

Gramineae	Dactyloctenium	aegyptium	(L.) Willd	Grass
Gramineae	Enteropogon	macrostachyus	K.Schum. ex Engl.	Grass

Gramineae	Chloris	gayana	Kunth	Grass
Gramineae	Urochloa	trichopus	(Hochst.) Stapf	Grass
Gramineae	Digitaria	nuda	Schumach.	Grass
Gramineae	Bothriochloa	insculpta	(A.Rich.) A.Camus	Grass
Gramineae	Sporobolus	vaginicus		Grass
Juncaceae	Juncus	sp		sedge
Lauraceae	Cassytha	filiformis	L	Herb
Labiatae	Plectranthus	flaccidus	Gürke	Herb
Labiatae	Ocimum	sp		Herb
Labiatae	Hyptis	suaveolens	Poit.	Herb
Leguminosae	Indigofera	tinctoria	L.	Herb
Leguminosae	Senna	didymobotrya	(Fresen.) Irwin & Barneby	Shrub
Leguminosae	Acacia	sp		Shrub
Leguminosae	Tephrosia	villosa	(L.) Pers.	Herb
Leguminosae	Teramnus	labialis	(L.f.) Spreng.	Herb
Leguminosae	Canavalia	rosea	(Sw.) DC.	Herb
Leguminosae	Tephrosia	pumila	(Lam.) Pers.	Herb
Malvaceae	Hibiscus	vitifolius	L.	Herb
Malvaceae	Thespesia	danis	Oliv.	Shrub
Malvaceae	Sida	ovata	Forssk.	Herb
Meliaceae	Azidiracta	indica		Tree
Moraceae	Ficus	sp		Tree
Pedaliaceae	Pedalium	murex	L.	Herb
Plumbaginaceae	Plumbago	zeylanica	L.	Herb
Rhamnaceae	Ziziphus	mucronata	Willd.	Tree
Rubiaceae	Psychotria	punctata	Vatke	Shrub
Rubiaceae	Diodia	aulacosperma	K.Schum.	Herb
Rubiaceae	Spermacoce	laevis	Lam.	Herb
Rutaceae	Zanthoxylum	sp		Tree
Sapindaceae	Allophylus	pervillei	Blume	Tree
Sapotaceae	Sideroxylon	inerme	L.	Tree
Sapotaceae	Mimusops	obtusifolia		Tree
Scrophulariaceae	Striga	gesnerioides	(Willd.) Vatke ex Engl.	Herb
Simaroubaceae	Harrisonia	abyssinica	Oliv.	Shrub
Solanaceae	Solanum	incanum	L.	Shrub

Solanaceae	Withania	somnifera	L.Dunal	Shrub
Solanaceae	Physalis	peruviana	L.	Herb
Sterculiaceae	Melhania	ovata	(Cav.) Spreng.	Herb
Sterculiaceae	Melhania	ovata	(Cav.) Spreng.	Herb
Ulmaceae	Trema	orientalis	(L.) Blume	Shrub
Verbenaceae	Lantana	camara	L.	Herb
Verbenaceae	Clerodendrum	glabrum	E.Mey.	Shrub
Verbenaceae	Premna	resinosa	(Hochst.) Schauer	Shrub
Vitaceae	Cyphostemma	sp		Herb

5.3 Fauna at the proposed project site

5.3.1 Data collection methodology

The methodology used in data collection for biodiversity survey to document biodiversity baseline at the proposed project site was both Secondary Data acquisition and primary data collection through biodiversity survey. Field survey was from conducted on the Terrestrial fauna; including insect pollinators, mammals, herpetiles (reptiles and amphibians) within the project footprint. Local residents were inquired for more information about the terrestrial fauna existing in the area. Herpetofauna survey involved the survey for reptiles and amphibians targeted areas where they can be observed easily in the morning. These include bare paths/roads, on stones/rocks, walls, on drainage features, near coastal shore and on tree stems. Local accounts were also used to populate list on herpetofauna in the area. Loose stones were turned over to find some species that prefers hiding under. Inspector pollinator survey Physical observation was used to assess the diversity of insect pollinators; comprising of the butterflies and bee families. Photographs of the species were acquired from the field as sample evidence. Mammal species survey included bat survey which was prioritized for this project due to the nature of the wind turbine project and anticipated impacts on mammal taxa.The survey was conducted by searching for their potential habitats or areas they would prefer for roosting in the day. These included search for caves, tall trees with dark shaded crown and desolated buildings. Potential foraging areas were identified by physical observation and accounts provided by the local residents. Adjacent areas with shrubs with active insect flights were indirectly used to identify potential foraging areas for insectivorous bats. Transects were used for other mammal species: Transect was used for physical search along the potential power turbine zone. Indirect method such as use of droppings assisted in

building checklist of mammals in the area. Accounts by local residents were also used to enrich the mammal species list.

CONSERVATION STATUS

The search engine for the IUCN Red list of threatened species 2016 (Fig. …..) was used to determine conservation status of the species. There are different categories of conservation status of species and are described in the IUCN red list data. These categories include Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Lower Risk, Data Deficient and Not Evaluated. Names of species were entered in the IUCN Red list search engine for verification. Conservation statuses are indicated for each species in biodiversity section below.

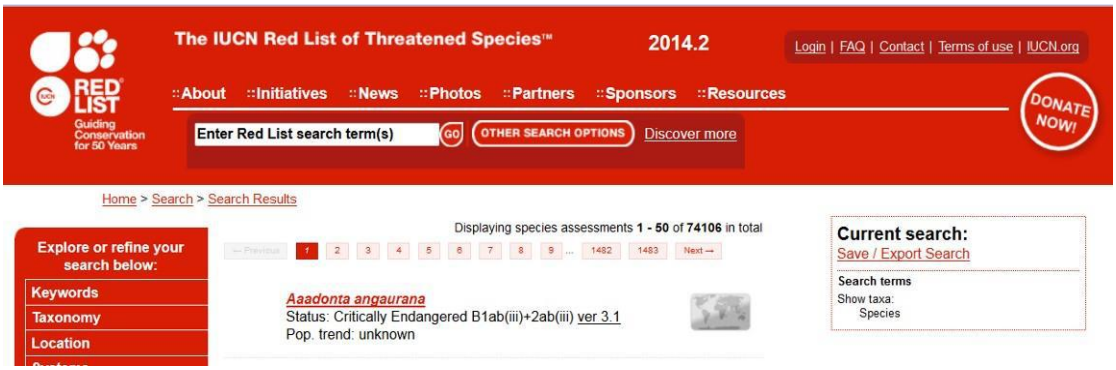


Figure 4: Search engine for the IUCN Red list of threatened species

According to the IUCN Red List a species is EXTINCT (EX) when there is no reasonable doubt that the last individual has died, or; EXTINCT IN THE WILD (EW) when it is extinct in the wild and it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range; CRITICALLY ENDANGERED (CR) when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria (A to E in the IUCN Red List Categories); ENDANGERED (EN) when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria (A to E in the IUCN Red List Categories); VULNERABLE (VU) when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria (A to E in the IUCN Red List Categories), and; LOWER RISK (LR) when it has been evaluated, does not satisfy the criteria for any of the categories

Critically Endangered, Endangered or Vulnerable. Species included in the Lower Risk category are separated into three subcategories:

1. Conservation Dependent (CD). Taxa which are the focus of a continuing taxonspecific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
2. Near Threatened (NT). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.
3. Least Concern (LC). Taxa which do not qualify for Conservation Dependent or Near Threatened.

A species would be given status of ―DATA DEFICIENT‖ (DD) when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. Lastly, a species is given status ―NOT EVALUATED‖ (NE) when it is has not been assessed against the IUCN criteria.

5.3.2 Habitats

Main land cover feature constituted habitat within the project area and its environ. Six distinct habitat features were observed in the area. These included the bare rocky areas; vegetated rocky areas; shrub land; mixed herb and grasslands; woodland, and; agroforestry areas. These habitats are described in details below.

Table 5: Habitats at the proposed project site

Habitats	**Description**
Bare Rocky area	Exposed to the sea and periodically sprayed by the raging storms. The rocks are continuous strata that extend from the sea cliffs.
Vegetated Rocky areas	Areas facing away from the sea. The rocks appear as outcrops. They do not experience sprays from storms in the sea water. Shrubs/herbs grow in between the rocks.
Shrubland	This zone follows the rocky area2 and mostly has soil with scattered stony areas. Some areas already affected by quarrying activities.

Mixed Herbs and Grassland	The zone occurs after shrubland towards hinterland. Some areas already affected by quarrying activities.
Woodland	This area is however small but has woody plant species. They appear like hedge trees on abandoned tracks.
Agroforestry	This areas consist of fruit plants such as mangoes and Coconut tree

5.3.3 Insect Pollinators (Butterflies and Bees)

Diverse butterfly species are observed within the shrubland and the mixed herbaceous plant and grassland. The area has quite a significant number of butterfly species (estimated at 34) but low in bee diversity (5 species). Sampling was conducted when the short rains were offing; thus vegetation on the landscape has flowering plants that highly attract butterflies and bees due to nectars. Butterflies are very conspicuous in the landscape and do not escapes notice. They can quickly inform on the status of vegetation species without undertaking rigorous study. Three species of butterflies are common in the area and these include *Papiliodemodocus*,*Junoniaoenone* and. *Euphaedraneophron*normally prefers forest patches but its presence here indicates presence of shrubs or bushes within the area. With regard to conservation status, the IUCN has no entries on butterflies probably implying no recorded threats yet.

Table 6: Butterfly species (LC = Least Concern)

Species	**CONSERVATION STATUS**
Acraea eponina	Least Concern
Acraea insignis	Least Concern
Amaurisniavius	Least Concern
Axiocersesharpax	Least Concern
Azanusjesous	Least Concern
Baliochilahildegarda	Least Concern
Belenoisaurota	Least Concern

Belenoiscreona	Least Concern
Bybliaanvatara	Least Concern
Bybliailithyia	Least Concern
Catopsiliaflorella	Least Concern
Colitis daira	Least Concern
Colitis euippe	Least Concern
Colotisantevippe	Least Concern
Colotisdanae	Least Concern
Colotisprotomedia	Least Concern
Colotis vesta	Least Concern
Euphaedraneophron	Least Concern
Euremabrigitta	Least Concern
Euremafloricola	Least Concern
Euremaregularis	Least Concern
Euryteladryope	Least Concern
Freyeriatrochylus	Least Concern
Graphiumangolanus	Least Concern
Hypolycaenaphilippus	Least Concern
Junoniahierta	Least Concern
Junonianatalica	Least Concern
Junoniaoenone	Least Concern
Junoniaorithya	Least Concern
Melanitisleda	Least Concern
Papiliodemodocus	Least Concern
Pardopsispunctatissima	Least Concern
Phalantaphalantha	Least Concern
Zizulahylax	Least Concern

The most common species in the family was Honey bees, which is a subset of bees in the genus *Apis*. *Apis mellifera* was observed in project area. Stingless bees *Melliponula spp*. was common on flowering herbs and their occurrence was dependent on availability of the herb species. Stingless bees normally inhabit hollow trunks, tree branches, underground cavities and wall cavities. Carpenter bees derive their name from the fact that nearly all species build their nests in burrows in dead wood, bamboo or structural timbers. However, the genus *Proxylocopa* nests in the ground. They were observed mostly on flowering shrubs and trees. None of the bee species recorded in the traverse feature in the IUCN Red List data.

Table 7: Conservation status for bees based on IUCN classification

Species	**IucnRedlist Category**
Apis mellifera	No Entry Found
Melliponula spp.	No Entry Found
Proxylocopa	No Entry Found
Xylocopa flavorufa	No Entry Found

The area is known to experience dry season that most of the flowering plants are not observed on the landscape. However, the butterfly species and population are resilient in the area. This is probably due to the ecology of the butterflies that they can spend most of their time at pupa stage during the dry season and when the landscape is vegetated they reach the larval stage to utilize the leaves. Thus, the area seems to be potential for breeding for butterflies.

5.3.4 Mammal: Bat

Potential habitat areas for bats were sited to be in agroforestry areas, woodlands and desolated buildings. Mapping of the habitats were based on the areas they roost and potentially forage from evening. Two major groups of bats were identified from the description of the local residents. These included the fruit eating bats and the insectivorous bat. The accounts provided by the local residents assisted in mapping the potential areas of distribution as shown on the maps. This area has large mango and coconut trees, and desolate buildings.

5.3.5 Mammals: Other Species

The commonly observed mammal species in the area are the African Savanna Hare and the Ground Squirrel. The African Savanna Hare was common in the survey site observed through their droppings. The area does not have conspicuous species of mammals; even the one recorded in this survey is merely an account from the local residents. Other species accounted for by the local residents include Four-toed elephant-shrew (*Petrodromustetradactylus*), Red-legged sun squirrel (*Heliosciurusrufobrachium*) and Four-toed hedgehog (*Eraniceusalbiventris*). Rats and moles were reported as freely occurring in the area. All the 5 mammal species recorded are accorded a Least Concern Category in the IUCN Red List.

Table 8: Conservation status of Mammal species based on IUCN Criteria

Common Name	**Scientific Name**	**Iucn Redlist Category**
Four-toed elephant-shrew	*Petrodromustetradactylus*	Least Concern
Red-legged sun squirrel	*Heliosciurusrufobrachium*	Least Concern
Four-toed hedgehog	*Eraniceusalbiventris*	Least Concern
African Savanna Hare	*Lepus microtis*	Least Concern
Ground Squirrel		

5.3.6 Herpetofauna survey

This group consists of reptiles; snakes, lizards, geckos, and amphibians including frogs and toads. Black Mamba was frequently observed crossing roads. Even remnant of Black Mamba eaten by prey bird was observed during the survey. Other species are accounted for by the local residents and these include Puff Adder and Speckled sand snake. Other herpetile species include Lizards and Skinks which were observed in the riparian rocky zones (see table below).

Table 9: Herpetofauna species encountered at the proposed project site

Common Name	Scientific Name	IUCN Redlist
Puff Udder	*Bitis arietans*	Least Concern
Speckled sand snake	*Psammophispunctulatus*	Least Concern
Black mamba	*Dendroaspispolylepis*	Least Concern
Variable ground skink	*Mabuya varia*	Least Concern
Long-tailed sand lizard	*Latastialongicaudata*	Least Concern
Day gecko	*Lygodactyluspicturatus*	Least Concern
Black-lined plated lizard	*Gerrhosaurusnigrolineatus*	Least Concern

5.4 Avifauna species at the proposed project site

5.4.1 Background Information

Birds are recognized as very good indicators of the state of the environment and the health of bird populations can be used as surrogates for success of conservation efforts as well as the lack of negative impacts on biodiversity by anthropogenic activities. Birds score very highly on many of the broad criteria defined for selecting indicator taxa (Pearson 1995). There are various reasons why birds are important indicators for biodiversity. According to BirdLife International (2013) and Hill *et al.*(2005), their most significant advantage is that much information about them, and their biology and life-histories are so well understood. Birds are also taxonomically well-known and stable, and their populations are readily surveyed and manipulated. Birds are widespread, occurring almost everywhere in the world. Bird families and genera often occupy a breadth of habitats and have broad geographical ranges, yet many individual species are specialized in their requirements and have narrow distributions. Birds are mobile and responsive to environmental changes. There are enough bird species to show meaningful patterns, yet not so many as to make identification itself a challenge. Birds have real economic importance in their own right-a useful attribute in an indicator.

Habitat use is the manner in which a species uses a collection of environmental components to meet life requisites. It is no wonder that in a given habitat, there will be a mixture of

species comprising of different feeding guilds because each species will specialize on a given food material as a mechanism to avoid competition. Bird families and genera often occupy a breadth of habitats and have broad geographical ranges, yet many individual species are specialized in their requirements and have narrow distributions.The habitat provides cover from weather and predators enhancing species survival and reproduction. More importantly, the habitats preferred by most bird species provide food and water for nourishment, nesting cover and roosting cover. Changes in bird population and abundance could therefore be a very good indicator of changing habitat conditions at a given site.

Birds fly at various heights due to their abilities to use different environmental strata. With proposed development of several wind turbines at Takaungu-Vipingo area, there is need to understand the various species using the proposed site and understand the potential impacts. A review of the literature identifies the main potential hazards to birds from wind farms to be disturbance leading to displacement or exclusion, including barriers to movement, collision mortality and loss of, or damage to, habitat resulting from wind turbines and associated infrastructure. These effects attributable to wind farms are variable and are species-, season- and site-specific (BirdLife International, 2003). A pre-construction ornithology survey is required to inform the Environmental Impact Assessment (EIA) process and is meant to identify potential impacts on species of conservation importance and those vulnerable to wind farm effects. Pre-construction surveys also provide the baseline data necessary for comparison with similar post-construction data collected.

Objectives of the Preconstruction Surveys

i. Undertake a comprehensive inventory of the species found at the proposed construction site
ii. Predict species and numbers of birds likely to be displaced or otherwise disturbed by the turbines, associated installations and staff.
iii. Predict species and numbers of birds likely to be killed by collision with rotors, turbine towers and other structures such as overhead lines.

5.4.2 Description of the Study Site

The study site is characterized by open areas comprising of the herbecaous layer (grasses, perennials and shrubs) not more than 1m tall. However, in the north of the property, there are dense thickets comprising of *Lantana camara, Azandracta indica, Recinus communis, Phyllanthus reticulates, Mimusopsobtusifolia, Cassia didimobotrya*and other species. There is a small stretch of woodland sandwiched in between but not owned by Mombasa Cement limited. On the west of the site is some farming activities (young and recent pawpaw and *Casuarina equistefolia* plantation). These represent efforts by DSML to rehabilitate certain areas of the site consistent with the mitigation measures recommended during previous EIAs associated with previous developments. The vegetation is occasionally burnt and this therefore influences the height of the flora, succession and plant species composition and diversity. The vegetation and species diversity is also influenced by the soil, which is mainly associated with coral and rocky outcrops. The site is also adjacent to the sea to the east.

5.4.3 Methodology

Birds were surveyed using point counts and opportunistic observations based on Bibby *et al*. (1998). Counts were undertaken in the morning hours (0700-1200hrs) when birds are very active. The procedure for point counts involve walking along transects and counting birds at a stations (or points) that are 200m apart. The observer stopped after every 200m at each point, after a two-minute settling-in period, the next ten minutes were spent recording all the birds observed and heard within or outside a 50m radius of a point that forms the centre. Identification of birds was based on Zimmerman, *et al*. (1996) and Stevenson and Fanshawe, (2002) and pairs of binoculars (8x40 magnifications) was be used. The naming of birds was based on the *Checklist of the Birds of Kenya* (NatureKenya, 2009). Birds were therefore be recorded as falling within or outside a-50m radius, whether seen or heard and their flight height noted as well as the flocks. The ten-minute observation will allow the observers more time to identify species and to detect those that vocalise infrequently. The transects were aligned with along the proposed line of turbines. The species were also categorised based on the migration status (resident, afrotropical migrants, Palaearctic) as well as their conservation status (Critically endangered, Endangered, Vulnerable, Near-threatened and Least Concern). In between the Point counts, opportunistic observation was also undertaken to record any species that had not been recorded during the normal point counts.

5.4.1 Results

A total of 63 species representing 32 families were recorded during the four day point survey conducted in August (14^{th}-15^{th}) and December (16^{th} – 17^{th}) 2016 (Figure 1). The two visits were meant to capture both resident and migratory species as December is the peak of the migration season. The most common families with at least three representatives were the Hirundinidae (swallows and martins), followed by the Accipritridae (diurnal birds of prey other than Falcons), Pycnonotidae (bulbuls) and Ploceidae (weavers, bishops and widowbirds). Opportunistic observations yielded additional four species not recorded on during the Point counts. This included lilac-breasted roller (*Coracias caudatus*), Greater honey guide (*Indicator indicator),* Violet-backed starling (*Cinnyricinclusleucogaster),* Long-tailed fiscal (*Laniuscabanisi).* This increased to 67 the number of species recoderd during the ornithological survey and families to 65.

6. BACKGROUND TO WIND ENERGY RESOURCE

Over 15,000 billion kWh of electricity are generated annually worldwide. Of this, about 65% is produced by burning fossil fuels and the remainder is obtained from other sources, including nuclear, hydropower, geothermal, biomass, solar and wind energy. (IEA, 2000). Only about 0.3% of this power is produced by converting the kinetic energy in the wind into electrical energy. (BTM Consult Press Release, 2002). However, the use of wind for electricity generation has been expanding rapidly in recent years, due largely to technological improvements, industry maturation and an increasing concern with the emissions associated with burning fossil fuels. There is still more room to grow, as only a small portion of the useable wind resource is being tapped. Government and electrical industry regulations, as well as government incentives, play a large role in determining how quickly wind power is adopted. Effective policies will help level the playing field and ensure that wind can compete fairly with other fuel sources in the electricity market.

6.1 Source of Wind Energy

Wind energy, like most terrestrial energy sources, comes from solar energy. Solar radiation emitted by the sun travels through space and strikes the Earth, causing regions of unequal heating over land masses and oceans. This unequal heating produces regions of high and low pressure, creating pressure gradients between these regions. The second law of thermodynamics requires that these gradients be minimized-nature seeks the lowest energy state in order to maximize entropy. This is accomplished by the movement of air from regions of high pressure to regions of low pressure, what we know as wind. Large-scale winds are caused by the fact that the earth's surface is heated to a greater degree at the equator than at the poles. (www.originenergy.com.au)

Prevailing winds combine with local factors, such as the presence of hills, mountains, trees, buildings and bodies of water, to determine the particular characteristics of the wind in a specific location. Because air has mass, moving air in the form of wind carries with it kinetic energy. A wind turbine converts this kinetic energy into electricity. The energy content of a particular volume of wind is proportional to the square of its velocity. Thus, a doubling of the speed with which this volume of air passes through a wind turbine will result in roughly a four-fold increase in power that can be extracted from this air. In addition, this doubling of

wind speed will allow twice the volume of air to pass through the turbine in a given amount of time, resulting in an eightfold increase in power generated. This means that only a slight increase in wind velocity can yield significant gains in power production.

6.2History of Harnessing Wind Energy

6.2.1 First Steps

Harnessing the wind for large-scale electric power generation is a relatively recent development. Wind had been used for hundreds of years to power sailing vessels and to drive windmills, but it wasn‘t until the late 19th century that the first wind turbine for electricity generation came into use. This windmill was built by Charles Brush (inventor of several technologies key to the then nascent electrical industry), stood 17 meters tall and had 144 rotor blades, and all made of cedar wood. Soon thereafter Poul la Cour, a Dane, discovered that fast rotating wind turbines with fewer rotor blades generated electricity more efficiently than slow moving wind turbines with many rotor blades. (http://www.windpower.org).

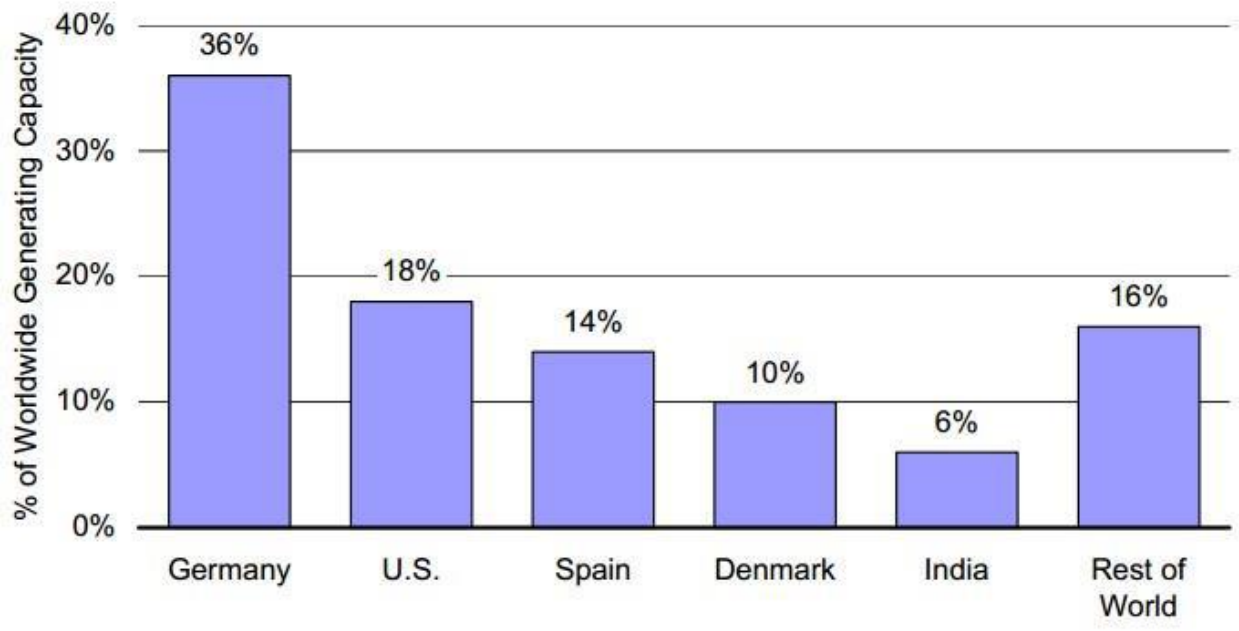
6.2.2 Twentieth Century Advances

This opened the door to a number of wind turbine advances during the 20th century. These included the introduction of AC generators, the standardization of the upwind model (in which the rotor is upwind of the nacelle), electromechanical yawing to ensure that the rotor always faces directly into the wind, and stall controls to keep the rotor from turning too fast in very strong winds. (http://www.windpower.org). Modern wind turbines make use of very few but very large blades to capture winds energy. Because these are large machines, they rotate relatively slowly, but generate large amounts of power while doing so. The oil crisis of 1973 boosted interest in large wind turbines and sparked several government-sponsored research programs in Germany, Sweden, Canada, the U.K. and the U.S. Because of these efforts, the cost of wind power on a per-kWh basis was cut in half in less than a decade.

Today‘s wind turbines generate power more cost-effectively than ever before, with the cost dropping from 38 cents per kWh in the early 1980‘s to between two and six cents today, depending on location (http://www.awea.org/faq/cost.html). Wind power approaches competitiveness with conventional generation at this price point.

6.2.3 Wind Power Today

Wind power is the world's fastest growing source of electricity. Generating capacity grew at an average annual rate of 25% between 1990 and 2000, exceeding less than 2% annual growth in each of nuclear, oil and natural gas, and an average annual decline of 1% in coal consumption over this period. (http://www.worldwatch.org/alerts/010517.html). As of the end of 2002 total global wind generating capacity exceeds 31,000 MW, and provides about 65 billion kWh of electricity annually. (http://www.awea.org/news/news030303gbl.html). Generating capacity is mainly concentrated in just five countries; Germany (36%), the U.S. (18%), Spain (14%), Denmark (10%) and India (6%) together account for 84% of the total (see Figure 6).



7: Distribution of Wind Power Generating Capacity Worldwide, 2001. Source: AWEA Global Wind Energy Market Report, March 2002

6.3 Kenya's Wind Energy Sector

According to United Nations Energy Programme (UNEP)'s Solar and Wind Energy Resource Assessment for Kenya, 2008, wind energy has been in use in the country since the turn of the 20th century. However, this use has been limited primarily to drawing water from boreholes in remote ranches and church mission outposts. The first utilization of wind to generate electricity was in the early 1990s through a Government of Belgium grant to the Kenyan government to supply power to Marsabit in the North of the country (UNEP'sKenya Country Report, Solar and Wind Energy Assessment, 2008). In 2003, the Ministry of Energy

developed a Wind Atlas to provide investors with indicative data on the strength and location of wind resources in Kenya.(http://www.renewableenergy.go.ke) UNEP‘s assessment estimates that Kenya has over 90,000 sq. km of excellent wind speeds. The best wind areas, irrespective of whether they will be economically viable if developed, include Marsabit, Samburu, parts of Laikipia, Meru north, Nyeri, Nyandarwa and the Ngong hills. Other areas of interest include Lamu, offshore Malindi, Loitokitok at the foot of Kilimanjaro and the Narok plateau (UNEP‘sKenya Country Report, Solar and Wind Energy Assessment, 2008).Wind speeds in all these areas range from 8-14 metres per second and are therefore able to support commercial electricity generation. However, the strong winds in Marsabit, Laisamis, Turkana and Samburu have specifically been identified as capable of producing over 1,000 MW of electricity.(Ministry of Energy, Wind Sector Prospectus, September 2013).

On-going projects include the Turkana Wind Park, Kipeto Energy Wind Park, Kinangop Wind Park, Ngong Wind Park Expansion, and the planned Mount Meru Wind Park. Overall, Kenya plans to increase its wind generation to 630 MW by the end of 2016 as part of its 5000+ MW Plan to expand overall electricity generation. This is in addition to the current 25.7 MW already in operation by KenGen at Ngong Wind Park.

The following provides a description of some of the current wind power projects that are operational or under development.

6.3.1 Ngong Hills Wind Farm

Located in Ngong Hills in Kajiado County, just 30 km west of Nairobi, the Ngong Hills Wind Farm (NHWF) has 6 Vestas V52-850kW wind turbines that contribute 5.1 MW to the national grid. The Ngong Hills Wind Farm is owned and operated by the Kenya Electricity Generating Company (KENGEN). The project is registered with the Clean Development Mechanism (CDM) registry as a CDM project under the UNFCCC and is expected to remove 9,941 metric tonnes of carbon dioxide (CO2) equivalent per annum.

6.3.2 Kipeto Wind Energy Project

The Kipeto Wind Energy Project is located in Kipeto area, Kajiado County, 60 km south of Nairobi. Although work on the project is yet to begin, it is estimated that, once complete,

Kipeto Wind Energy Project will add approximately 100 MW to Kenya‘s national electricity grid. The project is also designated as a CDM project and is expected to remove 253,469 metric tonnes of greenhouse gases (GHG) per annum. Kipeto Energy Limited (KEL) owns and will operate the project. KEL is registered in Kenya but the majority shareholder is USbased General Electric. The World Bank Group‘s investment arm, International Finance Corporation (IFC), and a Community Trust, a not-for-profit entity created for the purpose of receiving and managing a percentage of the income from the project for the benefit of the Maasai community, are its other shareholders. The Kipeto wind power project is funded by the Overseas Private Investment Corporation (OPIC), a US public agency that mobilises capital for private entities.

6.3.3 Lake Turkana Wind Power

Once operational, Lake Turkana Wind Power (LTWP) will be the largest wind power project in sub-Saharan Africa. LTWP will produce 310 MW of electricity from 365 wind turbines. LTWP is located in Loyangalani district, Marsabit County, in north-eastern Kenya. LTWP covers 40,000 acres (162 km2) and is owned and operated by Lake Turkana Wind Power Ltd, a company registered in Kenya but a wholly owned subsidiary of Netherlands-registered KP&P BV Africa. Other joint development partners include Aldwych International Limited, Vestas Wind Systems A/S and the Norwegian Investment Fund for Developing Countries, along with the Investment Fund for Developing Countries (IFU) Denmark and the Finnish Fund for Industrial Cooperation Ltd (Finnfund). LTWP is also registered as a CDM project and is expected to remove 736,615 metric tonnes CO 2 equivalent per annum.

6.4 Wind Energy Potential and Opportunities in Kenya

Kenya‘s wind installed capacity is 5.1 MW, operated by KenGen at the Ngong site. High capital cost and lack of sufficient wind regime data are some of the barriers affecting the exploitation of wind energy resources. Moreover, potential areas for wind energy generation are far away from the grid and load-centres, requiring high capital investment for the transmission lines The Ministry of Energy developed the Wind Atlas in 2003 to provide investors with indicative data on the strength and location of wind resources in Kenya. To augment the information contained in the Wind Atlas, the Ministry, with the assistance of Development Partners, is installing 53 Wind Masts and Data Loggers to collect site-specific data. The low exploitation level of the resource prompted the Government to develop the

Feed-in Tariffs (FiT) Policy which provides for a tariff not exceeding US Cents 11.0 per Kilowatt-hour of electrical energy supplied in bulk to the grid for wind generated electricity.

There are high wind speeds in various parts of northern Kenya and other arid lands. Preliminary wind resource assessments show that wind regimes in certain parts of Kenya (such as Marsabit, Ngong and the Coastal region) can support commercial electricity generation as they enjoy wind speeds ranging from 8 to 14 metres per second (m/s). Specific areas that have been identified for wind power generation are Marsabit, Laisamis, Turkana and Samburu.

These areas have potential to produce over 1,000 MW of wind power for sale to the national grid. This preliminary assessment has been used to develop a wind map for the whole country. To facilitate decision-making in wind power generation investment, the government is undertaking wind data logging in high potential areas of Kenya. However, detailed feasibility studies would be carried out to determine the viability of specific sites identified in the wind map. The Kenya Government would, therefore, like to invite the private sector to invest in wind power electricity generation. The potential for wind generation in Kenya is one of the highest in Africa with a total of 346 W/m^2. The average wind speed in large parts of the country reaches over 6 m/s, with the areas surrounding Lake Turkana (over 9 m/s) and the coast (5-7 m/s) being particularly attractive. There are between 10-20 locations with wind speeds greater than 7 m/s. With middle to large wind turbines, a total of over 1 GW could be achieved.

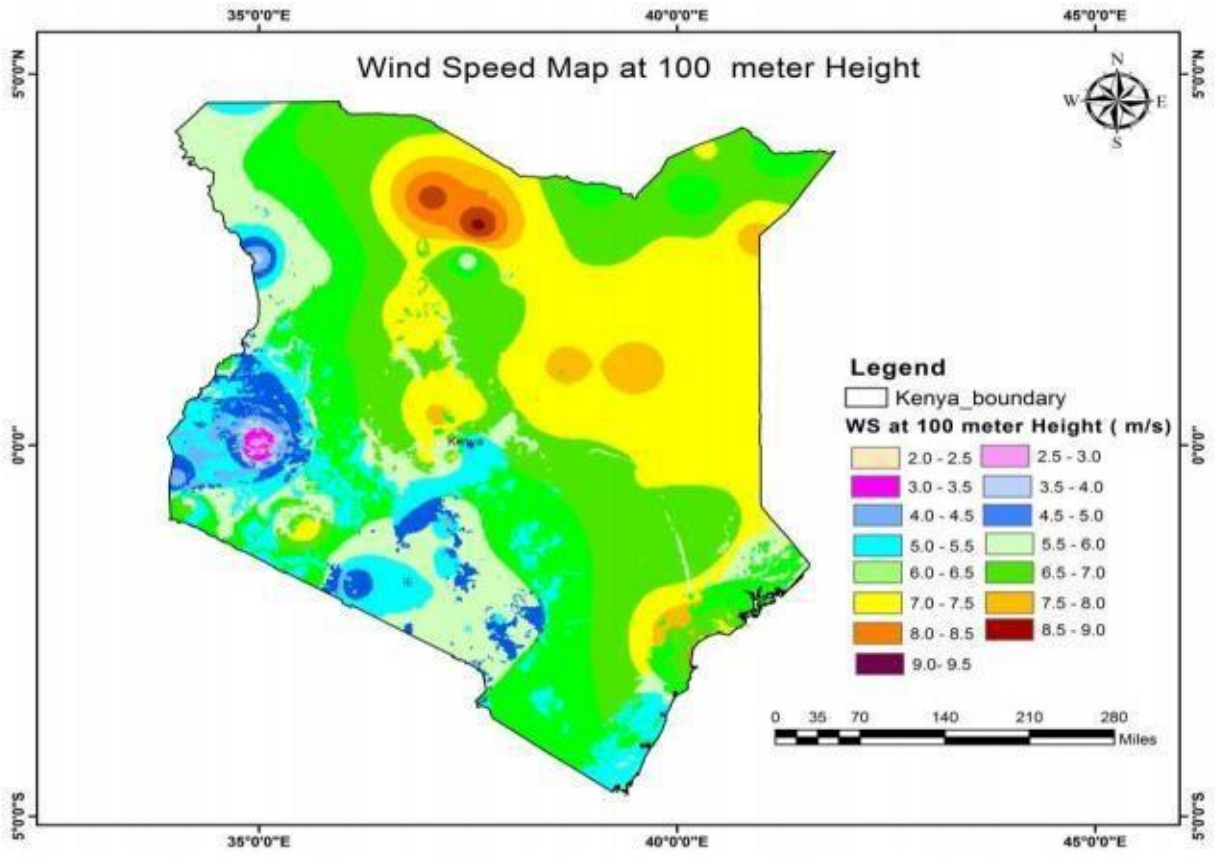


Figure 8: Wind speed map of Kenya

Source: Wind Sector Prospectus- Kenya, September 2013 Commissioned by the Ministry of Energy, Kenya.

7. WIND TURBINES

7.1 Introduction

A wind turbine is a mechanical assembly that converts the energy of wind into electricity. (http://www.windpower.org). The three key elements of any wind turbine are the rotor, the nacelle-which contains the gearbox, the generator and control and monitoring equipment (see Figure 8)-and the tower. Modern utility-scale wind turbines typically are equipped with threebladed rotors ranging from 42 to 80 meters in diameter, contain generators with rated capacity of between 600 kW and 2 MW, and are mounted on towers that are between 40 and 100 meters tall (see Figure 9). {Danish Wind Industry Association

(http://www.windpower.org)}. A utility-scale wind installation, called a wind farm or wind park, consists of a collection of these turbines.

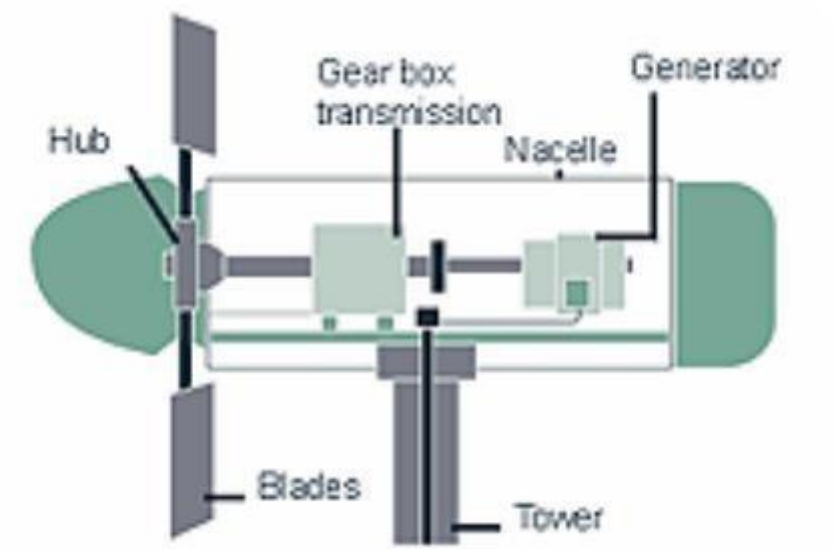


Figure 9: Nacelle Components. Source: Sustainable Energy Development Authority, NSW, Australia. (http://www.seda.nsw.gov.au/ren_wind_body.asp)

Figure 10: Wind turbine. Source: DOE/NREL (http://www.nrel.gov/data/pix)

7.2 Types of Turbines

There are two kinds of wind turbines, namely the Horizontal Axis Wind Turbine (HAWT) and the Vertical Axis Wind Turbine (VAWT). Though many VAWTs are used nowadays to produce electricity, the HAWT still remains more practical and popular than the VAWT and is assumed as the focus of most wind turbine discussions.

7.2.1 Horizontal axis wind turbines

The horizontal wind turbine is a turbine in which the axis of the rotor's rotation is parallel to the wind stream and the ground. Most HAWTs today are two- or three-bladed, though some may have fewer or more blades.

Figure 11: Atypical Horizontal axis wind turbine; (Source: www.windpowerengineering.com)

There are two kinds of Horizontal Axis Wind Turbines: the upwind wind turbine and the downwind wind turbine. The HAWT works when the wind passes over both surfaces of the airfoil shaped blade but passes more rapidly at the upper side of the blade, thus, creating a lower-pressure area above the airfoil. The difference in the pressures of the top and bottom surfaces results in an aerodynamic lift. The blades of the wind turbine are constrained to move in a plane with a hub at its center, thus, the lift force causes rotation about the hub. In addition to the lifting force, the drag force, which is perpendicular to the lift force, impedes rotor rotation.

7.2.1.1 Types of Horizontal Axis Wind Turbines

7.2.1.1.1 Upwind Turbine

The upwind turbine is a type of turbine in which the rotor faces the wind. A vast majority of wind turbines have this design. Its basic advantage is that it avoids the wind shade behind the tower. On the other hand, its basic drawback is that the rotor needs to be rather inflexible, and placed at some distance from the tower. In addition, this kind of HAWT also needs a yaw mechanism to keep the rotor facing the wind.

Figure 12: A typical Upwind Turbine (Source: www.windpowerengineering.com)

7.2.1.1.2 Downwind Turbine

The downwind turbine is a turbine in which the rotor is on the downwind side (lee side) of the tower. It has the theoretical advantage that they may be built without a yaw mechanism, considering that their rotors and nacelles have the suitable design that makes the nacelle follow the wind passively. Another advantage is that the rotor may be made more flexible. Its basic drawback, on the other hand, is the fluctuation in the wind power due to the rotor passing through the wind shade of the tower.

7.2.1.2 Advantages of Horizontal Axis Wind Turbines

The advantages of the HAWT over the VAWT, according to the Norwegian University of Science and Technology are:

- ✓ Blades are to the side of the turbine's centre of gravity, helping stability
- ✓ The turbine collects the maximum amount of wind energy by allowing the angle of attack to be remotely adjusted

- ✓ The ability to pitch the rotor blades in a storm so that damage is minimized
- ✓ The tall tower allows the access to stronger wind in sites with wind shear and placement on uneven land or in offshore locations
- ✓ Most HAWTs are self-starting
- ✓ Can be cheaper because of higher production volume

7.2.1.3 Disadvantages of Horizontal Axis Wind Turbines

- ✓ It has difficulties operating near the ground
- ✓ The tall towers and long blades are hard to transport from one place to another and they need a special installation procedure
- ✓ They can cause a navigation problem when placed offshore

7.2.2 Vertical axis wind turbines

The vertical axis wind turbine is an old technology, dating back to almost 4,000 years ago. Unlike the HAWT, the rotor of the VAWT rotates vertically around its axis instead of horizontally. Though it is not as efficient as a HAWT, it does offer benefits in low wind situations wherein HAWTs have a hard time operating. It tends to be easier and safer to build, and it can be mounted close to the ground and handle turbulence better than the HAWT. Because its maximum efficiency is only 30%, it is only usually just for private use

7.2.2.1 Types of vertical axis turbines

7.2.2.1.1 Darrieus Turbine

The Darrieus turbine is composed of a vertical rotor and several vertically oriented blades. A small powered motor is required to start its rotation, since it is not self-starting. When it already has enough speed, the wind passing through the airfoils generate torque and thus, the rotor is driven around by the wind. The Darrieus turbine is then powered by the lift forces produced by the airfoils. The blades allow the turbine to reach speeds that are higher than the actual speed of the wind, thus, this makes them well-suited to electricity generation when there is a turbulent wind

Figure 13: A typical Darrieus Turbine (Source: www.windpowerengineering.com)

7.2.2.1.2 Giromill Turbine

The Giromill Turbine is a special type of Darrieus Wind Turbine. It uses the same principle as the Darrieus Wind Turbine to capture energy, but it uses 2-3 straight blades individually attached to the vertical axis instead of curved blades. It is also applicable to use helical blades attached around the vertical axis to minimize the pulsating torque.

Figure 14: A typical Giromill Turbine (Source: www.windpowerengineering.com)

7.2.2.1.3 Savonius Turbine

The Savonius wind turbine is one of the simplest turbines. It is a drag-type device that consists of two to three scoops. Because the scoop is curved, the drag when it is moving with the wind is more than when it is moving against the wind. This differential drag is now what causes the Savonius turbine to spin. Because they are drag-type devices, this kind of turbine extracts much less than the wind power extracted by the previous types of turbine.

Figure 15: A typical Savonius Turbine (Source: www.windpowerengineering.com)

7.2.2.2 Advantages of Vertical Axis Wind Turbines

Just like the HAWT, the VAWT also comes with a handful of advantages over the HAWT, namely:

- ✓ Since VAWT components are placed nearer to the ground, it has an easier access to maintenance
- ✓ Smaller cost of production, installation, and transport
- ✓ Turbine does not need to be pointed towards the wind in order to be effective
- ✓ VAWTs are suitable in places like hilltops, ridgelines and passes
- ✓ Blades spin at a lower velocity, thus, lessening the chances of bird injury
- ✓ Suitable for areas with extreme weather conditions like mountains

7.2.2.3 Disadvantages of Vertical Axis Wind Turbines

- ✓ Most of them are only half as efficient as HAWTs due to the dragging force
- ✓ Air flow near the ground and other objects can create a turbulent flow, introducing issues of vibration
- ✓ VAWTs may need guy wires to hold it up (guy wires are impractical and heavy in farm areas)

7.3 How Wind Turbines Work

7.3.1 Aerodynamics

The blades of a wind turbine have an airfoil design such that the top half is curved and the bottom half is flat, as shown in the figure below. When laminar wind flows over the thicker, curved section of the blade, the wind initially slows down and then speeds up to match the speed of the relative wind. The increased speed of the wind above the airfoil produces a lowpressure region while the air below the airfoil remains at a higher pressure. This causes a phenomenon called lift, where the turbine blade is lifted perpendicular to the wind flow, towards the low-pressure region. The turbine blade also experiences drag, which is caused by friction along the blade. Drag (D) causes the resulting direction of lift (L) to change, as seen in Figure 5. Both effects of lift and drag cause the turbine blades to rotate around a rotor, which generates kinetic, or mechanical, energy. To determine whether the turbine is mostly affected by drag or lift, the tip speed ratio (α) can be calculated using;

$$\alpha = \frac{V_{rotor}}{V_{wind}}$$

Where $V_{rotor}$is the velocity of the rotor and V_{wind} is the velocity of the wind.

If $\alpha > 1$, lift force allows the blades to turn faster than the speed of the wind and, therefore, allows the turbine to output more power more efficiently. If $\propto < 1$, the turbine blades spin using drag force, which means that the maximum speed at which the blades can turn is the speed of the wind. The power produced by the wind can be calculated using Equation 2 where A is the cross sectional area of the rotor, ρ is the air density, and υ is the wind velocity.

$$P = \frac{1}{2} r \rho A v^2$$

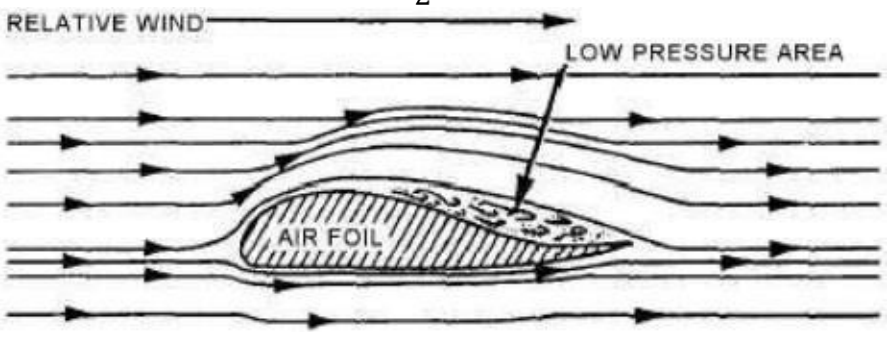


Figure 16: Laminar Flow over an Airfoi

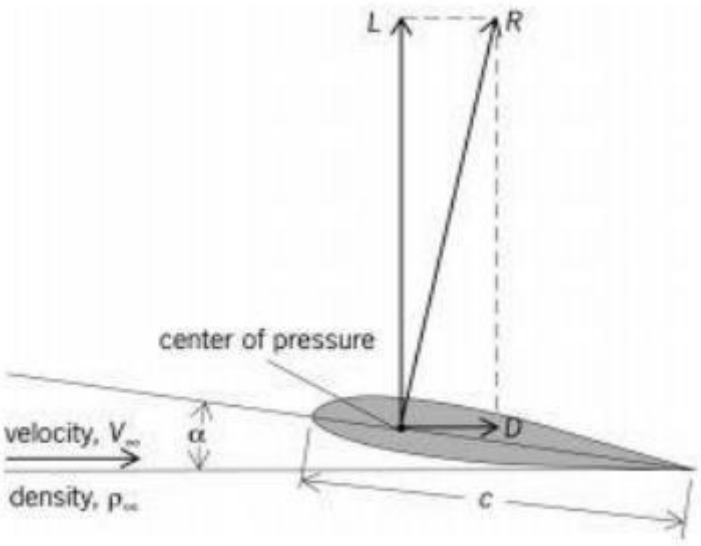


Figure 17: The Effect of Lift and Drag on an Airfoil

Electricity is produced in the nacelle, which holds the mechanical parts of the turbine that are essential to generating electricity. The generator converts the kinetic energy produced by the turbine blades into electrical energy.

8. WIND FARM LAYOUT OPTIMIZATION

8.1 Introduction

To maximize power outputs and minimize cost it is vital to optimize the placement of wind turbines. Wind turbines are usually grouped together into a wind farm to produce electrical power, in order to lower both installation cost and maintenance cost. But grouping turbines together, leads to a decrease in the power production because of the considerable effect of wind turbines on each other, which leads to considerable power loss. Therefore it is desirable to minimize the effect in order to maximize the power output. The wind farm layout optimization problem, or WFLOP, is about finding the right position for the wind turbine within the wind farm so the power production can be maximized and the wake effect can be minimized. Today, this problem is solved by simple rules that lead to layouts where the turbines are in a straight line, where the turbines are in identical rows and separated by an appropriate diameter.

8.2 Spacing and Line-Up of the Wind Turbines

To accommodate the factor that each wind turbine will slow down the wind behind it as it pulls energy out of the wind and converts it to electricity, the wind turbines ought to be spaced as far apart as possible in the prevailing wind direction or in the direction perpendicular to the prevailing winds in order to minimize energy losses but on the other hand, land use and the cost of connecting wind turbines to the electrical grid encourage to reduce the space between them. Therefore, a compromise must then be found between these two parameters. Usually, the space between turbines in wind parks is somewhere between 5 and 9 rotor diameters apart in the prevailing wind direction, and between 3 and 5 diameters apart in the direction perpendicular to the prevailing winds. In the below example, turbines (white dots) have been spaced by 7 diameters apart in the main wind direction and by 4 diameters in the perpendicular direction.

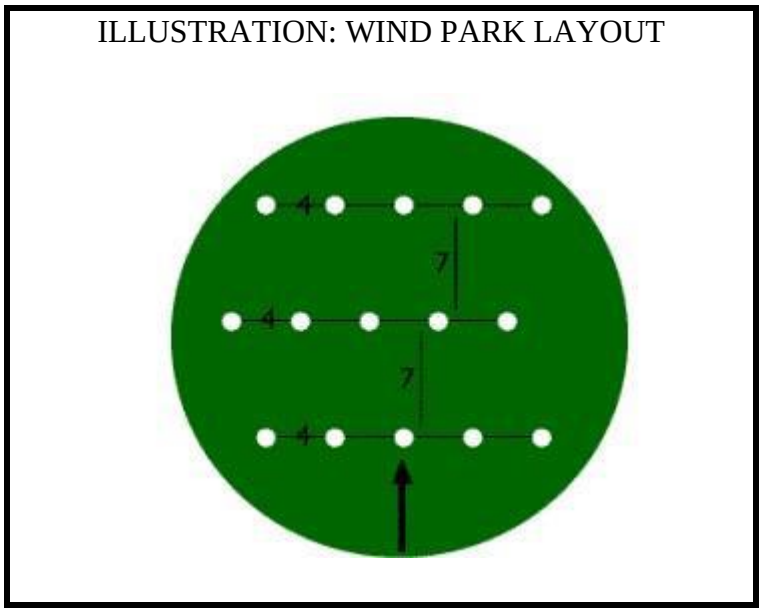


Figure 18: Wind park layout illustration (Source: www.windpower.org)

This arrangement in a straight line may in most instances not necessarily be the case in the final analysis following the feasibility studies but, in any case, the geometrically aesthetics should be put into consideration to appeal to the eye and ensure a beautiful fit into the landscape. A factor that may lead to fine-tuning off the straight line is the issue regarding shadows produced by the wind turbines and the effect of flickering, perceived by many as blinking, when the revolving rotor blades cut through sunlight. In light of this, the positioning of the wind turbine towers should also ensure that potential flickering does not pose gross

inconvenience to occupants of houses in the vicinity, where applicable. This could lead to adjustment along the following lines:

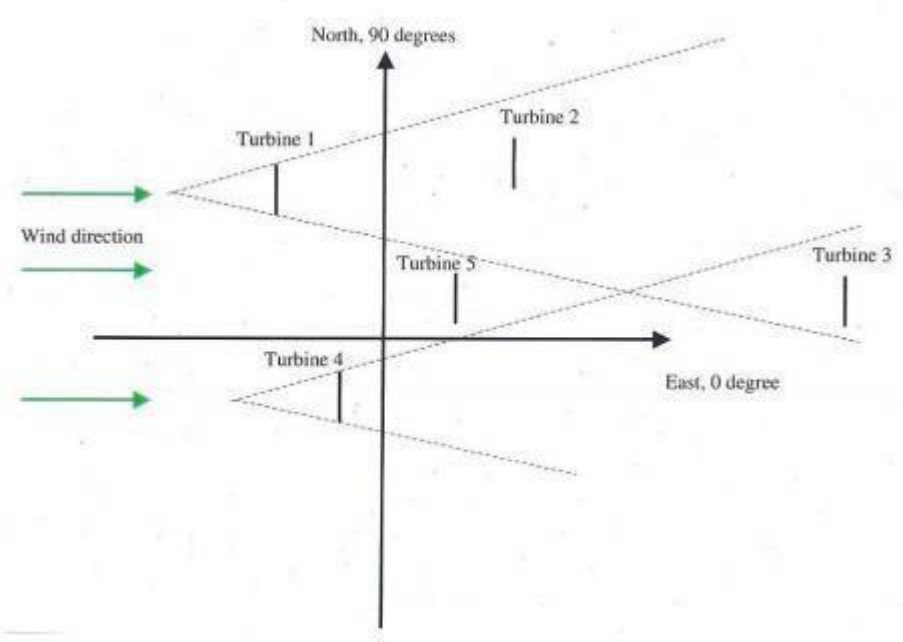


Figure 19: Illustration of positioning of wind turbine tower (source [www.windpower.org)](http://www.windpower.org)

8.3 Wind Turbine Siting Considerations

8.3.1 Local wind speeds

Accurate estimates of wind speed are critical to assessing the wind power potential at any location. Wind resources are characterized by wind power density classes, which range from Class 1 (the lowest) to Class 7 (the highest). However, estimates suggest that wind power generation on only 43,000 square kilometers of land-with less than 5% of this actually occupied by turbines, electrical equipment and access roads-could supply about 560 billion kWh of electricity annually.(D.L Elliott, M.N, 1993). The roughness of the surface across which the wind blows before arriving at a turbine determines the amount of turbulence that a turbine will experience. Turbulent winds put greater stresses on the rotor and tower, reducing the turbine‘s lifespan as a result. Thus, the vast majority of wind farms are in rural locations, away from wind-disrupting buildings, trees and other obstacles.

8.3.2 Proximity to existing power transmission grid

While the technical characteristics of the wind in a specific location are very important, many other factors also contribute to siting decisions. A location far removed from the power transmission grid might be uneconomic, as new transmission lines will be required to connect the wind farm to the grid. Existing transmission infrastructure may need to be upgraded to handle the additional supply. Soil conditions and the terrain must be suitable for the construction of the towers‘ foundations. Finally, the choice of a location may be limited by land use regulations and the ability to obtain the required permits from local, regional and national authorities.

8.3.3 Tower Height

Tower height affects the amount of power that can be extracted by a given wind turbine, as well as the stresses on the rotor and nacelle. One kilometre above the ground, wind speeds are not influenced by the terrain below. The wind moves more slowly at lower heights, with the greatest reduction in wind speed found very close to the ground. This phenomenon, known as wind shear, is the key factor when deciding on tower height, as higher rotors are exposed to faster winds. In addition, the difference in wind speeds between the top and bottom of the rotor decreases with height, causing less wear on the turbine.

9. DESCRIPTION OF THE PROJECT DESIGN

The proposed wind farm will be onshore (away from water) and will be built by installing twelve wind turbines in a grid to generate electricity to the national grid. The design components of the wind farm will include wind turbines complete with all necessary auxiliary facilities, overhead power line and access roads. Electricity generated will be fed to an existing nearby sub-station and power transmission grid within the premises of Mombasa Cement Limited.

9.1 Turbine design

The components of a wind turbine are nacelle, rotor blades, hub, low speed shaft, gearbox, high speed shaft with its mechanical brake, electrical generator, yaw mechanism, electronic controller, hydraulics system, cooling unit, tower, anemometer and wind vane (figure 19). The proposed wind farm will consist of twelve Vestas V90 3MW turbines which are pitch regulated upwind wind turbines with active yaw and a three-blade rotor. This turbine has a rotor diameter of 90 m with a generator rated at 3.0 MW. The turbine utilises the OptiTip and the variable speed concepts. With these features rated power is maintained even in high wind speeds, regardless of air temperature and air density, and the wind turbine is able to operate the rotor at variable speed (RPM). At low wind speeds the OptiTip system and variable speed operation maximise the power output by giving the optimal RPM and pitch angle, which also minimises the sound emission from the turbine. Operating data for the turbines is as follows; rated power 3,000 kW (50Hz); cut-in wind speed (the lowest mean wind speed at hub height at which the wind turbine starts to produce power) 3-5 m/s; rated wind speed (the lowest mean wind speed at hub height at which the wind turbine produces the rated power) 15 m/s; cut-out wind speed (the maximum wind speed at hub height at which the wind turbine must be shut down) 25 m/s; operating temperature range: standard: 20° to 40° C low; power regulation: pitch regulated with variable speed; maximum sound power 107 dB; mode 0,10 m above ground, hub height 80 m, air density 1.225 kg/m^3. The components of this turbine are as follows foundation, tower, nacelle, rotor blade, and hub.

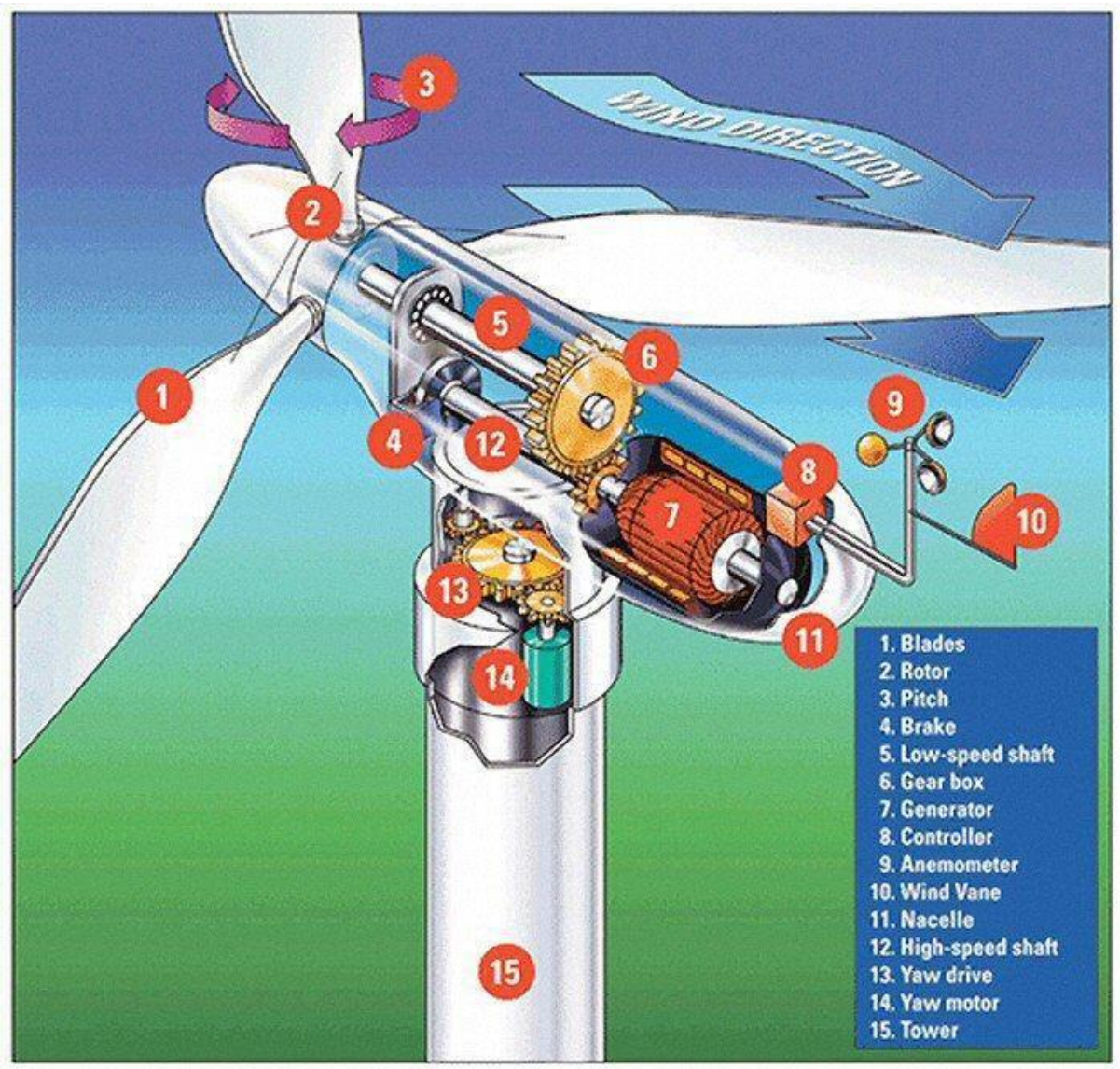


Figure 20: Components of a wind turbine

9.2 Turbine foundation

Depending on the outcome of site specific geotechnical investigation report (which is yet to be undertaken), the turbines will either be anchored on shallow foundations (which can be an octagonal gravity base foundation, rock anchor foundation or anchor cage foundations) or deep foundations which are typically a pile group with a pile cap. In an octagonal gravity base foundation the loads induced by the wind turbine are distributed to the surrounding soil through a large octagonal reinforced concrete foundation. A pedestal is provided at the centre to support the tower. This type of foundation has a typical diameter of 12 to 18 m, thickness of 0.7 m at the edge and 2.5 to 3.5 m at the centre, contains 120 to 460 cubic meters of

concrete and typically embedded 2.4 to 3.0 m beneath the ground surface. In the case of an anchor cage foundation, it consists of a set of bolts held together by steel rings. The bolts and rings are mounted together. Before assembling the steel rings and bolts, the site is prepared by excavating a hole and laying about 20 cm of concrete. The anchor cage is positioned in the middle and can be assembled in the excavated area or nearby area. The reinforcement bars are also provided and finally the concrete is poured. The tower is attached to the foundation using bolts and tensioned; the shape of the foundation could be either circular of octagonal. The rock anchor foundation on the other hand is suitable only when strong bedrock is encountered at a shallow depth. The load from the wind turbine is resisted by the combination of bearing pressure beneath the cap at the bearing layer and tension in the steel bars grouted into boreholes that are post-tensioned after placement. The rock anchor helps to fix the foundation and prevent the uplift of the foundation. Such foundation can reduce the foundation area and minimize the use of concrete and reinforcement

The selection of the appropriate foundation will depend on the site conditions, available design and analysis procedures and constructability at the site. The shallow foundation will be used if the outcome of the geotechnical site specific report shows that the top level soil is capable of adequately supporting the superstructure. If the geotechnical report reveals that the upper soil layer is weak and is not capable to carry the load, a deep foundation will be used to reduce the excessive differential settlement by transferring the load to a deeper stronger soil layer or bedrock.

9.3 Tower

The tower on which a wind turbine is mounted is a support structure that raises the wind turbine so that its blades safely clear the ground and so it can reach the stronger winds at higher elevations. Maximum tower height is optional in most cases, except where zoning restrictions apply. The decision of what height tower to use will be based on the cost of taller towers versus the value of the increase in energy production resulting from their use. Studies have shown that the added cost of increasing tower height is often justified by the added power generated from the stronger winds. The tower of the wind turbine carries the nacelle and the rotor. The turbine tower will be a tubular steel tower, manufactured in sections of 2030 metres with flanges at either end, and bolted together on the site. The tower is conical (i.e. with its diameter increasing towards the base) in order to increase its strength.

Specifications of the tower for the Vestas V-90 are as follows:-

- ✓ Type: Conical tubular
- ✓ Material: S355
- ✓ Surface treatment: Painted
- ✓ Corrosion class, outside: C4 (ISO 12944-2)
- ✓ Corrosion class, inside: C3 (ISO 12944-2)
- ✓ Top diameter for all towers: 2.3 m
- ✓ Bottom diameter for all towers: 3.98 m
- ✓ Colour light grey

9.4 Nacelle

The nacelle(figure 20)contains the key components of the wind turbine, including the gearbox, and the electrical generator. The nacelle holds all the turbine machinery; it is made of machine foundation (the bedplate), gearbox, yaw system, brake system, generator, and transformer, cooling and air-conditioning system.

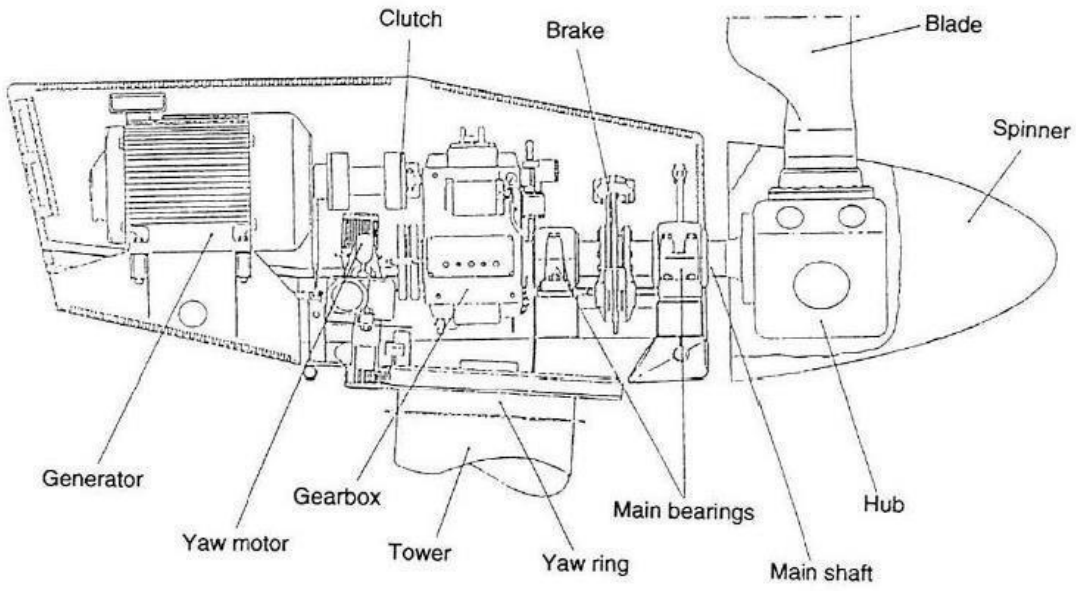


Figure 21: Wind turbine components inside the nacelle

The nacelle cover is made of fibreglass; an opening in the floor provides access to the nacelle from the tower. The roof section is equipped with skylights, which can be opened to access the roof and the wind sensors. Wind sensors are mounted on the nacelle roof. Aviation lights, if any, are also

placed on top of the nacelle. The front of the nacelle bedplate is the foundation for the drive train, that transmits forces and torque from the rotor to the tower, through the yaw system. The front of the nacelle bedplate is made of cast steel. The nacelle cover is mounted on the nacelle bedplate. The nacelle bedplate is in two parts and consists of a cast iron part and a girder structure. The cast iron part serves as the foundation of the main gear and the generator. The bottom surface is machined and connected to the yaw bearing. The crane beams are attached to the top structure. The lower beams of the girder structure are connected at the rear end. The rear part of the bedplate serves as the foundation for controller panels, cooling system and transformer. The four yaw-gears are bolted to nacelle bedplate. The nacelle houses the internal 800 kg SWL service crane. The crane is a single system chain hoist. If any heavier parts need service, the service crane can be upgraded to 1600/10000 kg SWL. The upgraded crane is able to lift and lower large elements such as parts of the gearbox and the generator.

The main gear transmits the torque from the rotor to the generator. The gear unit is a combination of a 2-stage planetary gear and a 1-stage helical gear. The gear housing is bolted to the bedplate. The low speed input shaft is bolted directly to the hub without the use of a traditional main shaft. The gearbox lubrication system is a forced feed system without the use of an integrated oil sump. The yaw bearing system is a plain bearing system with built-in friction. The system enables the nacelle to rotate on top of the tower. The system transmits the forces from the turbine-rotor/nacelle to the tower. The turbine brakes by full-feathering of the rotor blades. The individual pitch cylinders ensure triple braking safety. Furthermore, a hydraulic system supplies pressure to a disc brake located on the main gear high-speed shaft. The disc brake system consists of 3 hydraulic brake callipers. The generator is an asynchronous 4-pole generator with a wound rotor. Variable speed allows varying the rotor speed within a wide speed range. This reduces power fluctuations in the power grid system as well as minimises the loads on vital parts of the turbine. Furthermore, the variable speed system optimises the power production, especially at low wind speeds. Variable speed technology enables control of the turbine reactive power factor between 0.96 inductive and 0.98 capacitive measured on the low voltage side. The generator is water-cooled. The step up transformer is located in a separate compartment to the rear of the nacelle. The transformer is a three phase dry-type cast resin transformer specially designed for wind turbine applications. The windings are delta connected on the medium voltage-side unless otherwise specified. The windings are connected in star on the low voltage-side (1000 V and 400 V). The 1000 V and

400 V systems in the nacelle are a TN-system, where the star point is connected to ground. Surge arresters are mounted on the medium voltage (primary) side of the transformer. The output voltages available are in 0.5 kV steps from 10 to 34.5 kV where 36kV (Um) is the highest equipment peak voltage. The transformer room is equipped with arc detection sensors. If the inside air temperature of the nacelle exceeds a certain level, flap valves will open to the outside. A fan engine will draw in outside air for cooling the nacelle air. Gear lubrication oil, generator cooling water and the variable speed unit are cooled from a separate air intake, using separate water/air cooling systems. Water coolers are thermally insulated from other parts of the nacelle. A separate fan cools the transformer. The heat exchanger system is mounted in a separate compartment in the upper rear section of the nacelle.

The specifications of the nacelle for the Vestas V-90 including hub and nose cone are as follows:-

- ✓ Material: Fibreglass
- ✓ Length: 13.25 m
- ✓ Width: 3.6 m
- ✓ Height: 4.05 m
- ✓ Weight app. 88000 kg +/- 3000 kg

The specifications of the nacelle without hub and nose cone are as follows:-

- ✓ Length: 9.65 m
- ✓ Width: 3.6 m
- ✓ Height: 4.05 m
- ✓ Weight app.: 68000 kg +/- 2000 kg

The specifications of Nacelle Bedplate are as follows:-

- ✓ Front part: Spheroidal graphite iron GJS-400-18U-LT
  Foundation for gear, generator, yaw bedding, crane-girders and rear foundation.
- ✓ Weight: 8500 kg
- ✓ Rear part: Welded gratings integrated with crane girders.
  Foundation for electrical panels, transformer and cooling room

9.5 Rotor

The part of the wind turbine that collects energy from the wind is called the rotor. The rotor is the component which, with the help of the rotor blades, converts the energy in the wind into rotary mechanical movement. The hub/ nose cone of the rotor V90 is mounted directly onto the gearbox, thereby eliminating the main shaft traditionally used to transmit the wind power to the generator through the gearbox. The V90 is equipped with a microprocessor controlled ® pitch control system called OptiTip .Based on the prevailing wind conditions, the blades are continuously positioned to the optimum pitch angle. The pitch mechanism is placed in the hub. Changes of the blade pitch angle are made by hydraulic cylinders, which are able to rotate the blade 95°. Every single blade has its own hydraulic pitch cylinder. A hydraulic system produces hydraulic pressure for the pitch systems in the hub. In case of grid failure or leakage, a backup accumulator system provides sufficient pressure to pitch the blades and stop the turbine. A collector system prevents oil leaks, if any, from spreading outside the hub. The blades are made of fibre glass reinforced epoxy and carbon fibres. Each blade consists of an inner beam encircled by two shells. The blades are designed for optimised output and minimised noise and light reflection. The V90 blade design minimizes the mechanical loads applied to the turbine. The blade bearing is a double raced 4-point ball bearing bolted to the blade hub. Each blade has a lightning protection system consisting of lightning receptors on the blade tip and a copper wire conductor inside the blade.

The following are the technical specification of the rotor for the Vestas V-90

- ✓ Diameter: 90 m
- ✓ Swept area: 6362 m^2
- ✓ Speed, nominal power: 16.1 RPM Speed, Dynamic operation range
- ✓ Rotor: 9.9 - 18.4 RPM
- ✓ Rotational direction: Clockwise (front view)
- ✓ Orientation: Upwind
- ✓ Tilt: 6°
- ✓ Blade coning: 4°
- ✓ Number of blades: 3
- ✓ Aerodynamic brakes: Full feathering

The specifications for the rotor blades are as follows:-

- ✓ Principle: Airfoil shells bonded to supporting beam
- ✓ Material: Fibreglass reinforced epoxy and carbon fibres
- ✓ Blade connection: Steel root inserts
- ✓ Air foils: RISØ P + FFA-W3
- ✓ Length: 44 m
- ✓ Weight: 6600 kg/pcs +/- 400 kg
- ✓ Chord at blade root: 3.512 m
- ✓ Chord at blade tip: 0.391 m
- ✓ Twist (blade root/blade tip): 17.5°

9.6 Hub

The hub holds the rotor together and transmits motion to nacelle. The hub is the center of the rotor to which the rotor blades are attached it is made of cast iron. The hub directs the energy from the rotor blades on to the generator. The hub is connected to the slowly rotating gearbox shaft, converting the energy from the wind into rotation energy.

Specifications for the hub for the Vestas V-90 are as follows

- ✓ Type: SG Cast Iron
- ✓ Material: GJS-400-18U-LT
- ✓ Weight: 8500 kg

The exact hub height listed includes 0.55 m distance from the foundation section to the ground level and 2.0 m distance from the tower top flange to the hub centre.

9.7 Layout design of the wind farm

Lay out design of the wind farm is yet to be fully developed; management is at the preliminary stage of developing and designing the proposed wind farm. As currently envisaged, the components of the proposed wind farm will include among other things twelve wind turbines, transformers, and overhead power cables evacuating the electricity generated from the wind farm to an existing sub-station within DSMLVipingo site. The preliminary layout design of the proposed wind farm indicate that the turbines will be in one line (figure 22). Spacing between turbines will be maintained at 350 meters, just under 4 rotor diameters.

9.8 The physical area to be affected by the project activity

The nature of the proposed project is construction of a wind farm , the physical area that will be affected by the project activity will include the following:-

- ✓ The actual site where the construction of the and installation of the various components of the wind farm and allied infrastructure will take place
- ✓ The actual area/location where there will be temporary holding of construction and project materials.
- ✓ The actual area/location where there will be temporary holding of waste resulting from construction work
- ✓ The road that will be used to transport project materials to site.

9.9 Waste generation

Waste likely to be generated from implementation of the proposed wind farm project will include vegetation material that will be cleared from the proposed project site, soil and any rock material that will be excavated from the proposed project site, empty cement bags from the use of cement on site, carton boxes, polythene, kaki paper wrappings, nylon strips, wooden pallets and other materials used to package the various components of the wind farm. During operation of the wind farm waste that could be generated will be as a result of maintenance works this may include replacing worn-out infrastructure. Waste that will be generated from decommissioning phase will include worn-out wind turbines and allied infrastructural components.

9.9.1 Waste management

All waste to be generated from the implementation of the proposed project during construction, operation and decommissioning of the wind farm will be managed and disposed as stipulated in the Environmental Management and Coordination (Waste Management) Regulations, 2006.

9.10 Project cost

The estimated cost of the implementation of the proposed wind farm as given by the proponent is KSH 260, 000,000 (Kenya Shillings two hundred and sixty million). 0.1% of the

stated project cost has already been paid to the National Environment Management Authority as prescribed in the EIA/EA regulations.

10. PROJECT ALTERNATIVES

10.1 Alternative types of wind turbines

There are two basic types of wind turbines namely those that rotate around horizontal axis referred to as horizontal axis wind turbines and those that rotate around the vertical axis referred to as vertical axis wind turbines. The proposed wind farm project intends to install horizontal axis wind turbines as an alternative to vertical axis wind turbines.

10.1.1 Horizontal axis wind turbines - the preferred alternative

Horizontal axis wind turbines have the main rotor shaft and electrical generator at the top of a tower, and they must be pointed into the wind. Notwithstanding the disadvantages of the horizontal axis wind turbines such as construction of massive towers, lifting into position of heavy turbine components such as gearbox, rotor shaft and brake assembly, an additional yaw control mechanism to turn the blades toward the wind, requirement of a braking or yawing device in high winds to stop the turbine from spinning and destroying or damaging itself; the horizontal axis wind turbines are preferred because:-

- The tall tower base allows access to stronger wind in sites with wind shear. In some wind shear sites, every ten meters up the wind speed can increase by 20% and the power output by 34%.
- High efficiency, since the blades always moves perpendicularly to the wind, receiving power through the whole rotation.

10.1.2 Vertical axis wind turbine - the other alternative

Vertical axis wind turbines have the main rotor shaft arranged vertically, the wind turbine does not need to be pointed into the wind hence advantageous on sites where the wind direction is highly variable or has turbulent winds. With a vertical axis wind turbines, the generator and other primary components can be placed near the ground, so the tower does not need to support it, also makes maintenance easier. Notwithstanding the advantages of vertical axis wind turbines such as can be located nearer the ground, making it easier to maintain the

moving parts; no yaw mechanisms is needed; may be built at locations where taller structures are prohibited; have lower wind start-up speeds, vertical axis wind turbines were not preferred because of their disadvantages such as:-

- Most vertical axis wind turbines have an average decreased efficiency from a common horizontal axis wind turbine, mainly because of the additional drag that they have as their blades rotate into the wind.
- Rotors of vertical axis wind turbines are located close to the ground where wind speeds are lower and do not take advantage of higher wind speeds above.
- Vertical axis wind turbines, involve various types of reciprocating actions, requiring air foil surfaces to backtrack against the wind for part of the cycle. Backtracking against the wind leads to inherently lower efficiency.

10.2 Turbine design alternatives

A wind turbine consist of tower and foundation, nacelle with drive train (gearbox, generator), rotor and rotor blade, hub and other components such as systems to track wind directions, cooling and heating elements, lightning protection equipment, cranes and elevators, and fire extinguishing equipment.

10.2.1 Wind turbine tower designs

There are about four types of designs of a wind turbine tower namely tubular conical tower, lattice tower design, guyed pole tower design and hybrid tower. A tubular steel tower is manufactured in sections of 20-30 metres with flanges at either end, and bolted together on the site. The tower is conical (i.e. with their diameter increasing towards the base) in order to increase their strength and to save materials at the same time. A lattice tower is manufactured using welded steel profiles. The lattice towers requires only half as much material as a freely standing tubular tower with a similar stiffness for aesthetic reasons lattice towers have almost disappeared from use for large, modern wind turbines. Guyed pole towers are built with narrow pole towers supported by guy wires. Guyed pole tower is light in weight thus savings in cost. However it is more prone to vandalism, thus compromising overall safety. A hybrid tower is made using a combination of different techniques of tubular conical tower, lattice tower and guyed pole tower

Tubular conical turbine tower design – the preferred alternative

The proposed projects intend to use a tubular conical turbine tower which is the most commonly used tower for large modern wind turbines with a number of advantages including its stable base and ability of one to move in it due to the tubular nature as an alternative lattice tower design, guyed pole tower design or hybrid tower. The advantage of lattice towers is cost, since a lattice tower requires only half as much material as a freely standing tubular tower with a similar stiffness. The disadvantage of lattice towers is that they can potentially increase bird mortality as lattice tower tend to attract nesting of birds increasing their potential to collide with the blades as they try to nest. The advantage of guyed pole tower is weight savings, and thus cost. The disadvantages are difficult access around the towers which make them less suitable, guyed pole tower is more prone to vandalism, thus compromising overall safety.

10.2.2 Turbine blade design

Blade designs operate on either the principle of drag or lift. The proposed wind farm will use wind turbine blades designed based on the lift design principle as opposed to drag design blades.

10.2.2.1 Lift blade design - preferred alternative

The lift blade design uses the Bernouli aerodynamic lift force that an airfoil feels in a moving stream or air. In this design, when air flows past the blade, a wind speed and pressure differential is created between the upper and lower blade surfaces. The pressure at the lower surface is greater and thus acts to "lift" the blade. When blades are attached to a central axis, like a wind turbine rotor, the lift is translated into rotational motion. Lift-powered wind turbines have much higher rotational speeds than drag types and therefore well suited for electricity generation.

10.2.2.2 Drag blade design – the other alternative

In the drag design, the wind literally pushes the blades out of the way. Drag powered wind turbines are characterized by slower rotational speeds and high torque capabilities. They are useful for the pumping, sawing or grinding work.

10.2.3 Number of rotor blades

The part of the wind turbine that collects energy from the wind is called the rotor. The rotor usually consists of two or more wooden, fiberglass or metal blades which rotate about an axis (horizontal or vertical) at a rate determined by the wind speed and the shape of the blades.

The blades are attached to the hub, which in turn is attached to the main shaft.

10.2.3.1 Three-blade rotor – preferred alternative

The proposed project proposes to use three- blade rotor turbine as opposed to two or one because the three-blade rotor is the most efficient for power generation by large wind turbines. In addition, the use of three rotor blades allows for a better distribution of mass, which makes rotation smoother and also provides for a "calmer" appearance. A three-bladed wind turbine has infinite principle axes in the plane swept by the blades, which makes it the most efficient turbine design without having any dynamic issues.

10.2.3.2 Two-blade rotor

Notwithstanding the fact that a two-blade rotor turbine sweeps 180 degrees before reaching the wake of the other blade and hence potentially more efficient than a three-blade rotor; its main disadvantage is that it creates yaw chatter when the turbine rotates (yaws) to face the wind. The yaw chatter is a harmonically oscillating yaw rate which results in a lot of noise, vibration, and stress on the tower. This basically happens because there are two distinct principle axes of moment of inertia in the plane swept by the turbine blades: parallel to the blades and perpendicular to the blades.

10.2.3.3 One-blade rotor

The fact that a one blade-rotor turbine sweeps 360 degrees before encountering its wake hence potentially more efficient than a two or three-blade rotor turbine, its main disadvantage is having one blade causes many problems structurally and dynamically.

10.3 Project site alternatives

10.3.1 Proposed project site

The wind power site is located on the premises of Devki Steel Mills Ltd. Whereas detailed wind measurements on site to obtain prerequisite wind data are required for the determination

of the appropriateness of the proposed project site for production of electricity from wind and for the development of the appropriate design of the wind farm, a wind speed information and annual energy production calculation report based on Modern Era Retrospective-analysis for Research and Applications (MERRA) from NASSA and the National Climatic Data Centre (NCDC) of the USA has been prepared (appendix 9). Based on this report, the following factors favour the choice of the proposed site:-

- ✓ The land is owned by Devki Steel Mills Limited effectively eliminating requirements of land acquisition and associated negotiations.
- ✓ The landscape can be characterized as flat, open and non-complex which makes its accessibility relatively convenient and movement of turbines during installation, service and maintenance relatively convenient.
- ✓ This land is at an elevation of 7-15 m above the ocean and there is a steep cliff (~10 m) at its eastern edge, towards the ocean this makes designing of an onshore wind farm less complex.
- ✓ The very dominant direction of wind on this site is south, wind speeds are steady and occurrence of very high wind speeds is low, site wind speeds shows relatively small distribution, spread around the central and mean values are small.
- ✓ These site wind conditions favour the site for production of electricity from wind using a low-wind turbine that is a turbine which reaches rated capacity at a low wind speed rather than one with higher. This favours the V90 turbine.

10.3.2 Alternative project sites

Many locations in Kenya have significant wind resource and thus are potential alternative project site with potential to harness wind resource to generate electricity. These include Ngomeni, Nairok, Hola, GarisaBaragoi among other many areas as identified in the Kenya Wind Prospectus report. However these potential alternative sites are not viable for the proposed project because DSML does not own any land in these alternative sites that can be used for the project.

11. OCCUPATIONAL SAFETY AND HEALTH

11.1 Introduction

Occupational Health and Safety (OHS) is of importance at project sites. It is important for mechanisms to be put in place to predict potential risks, incidents and hazards in the said working environment. This is because the occupational environment directly affects employees involved in project, the neighbourhood, visitors, contractors, sub-contractors and the general public. Therefore before commissioning of the project, a number of safety measures have to be in place to ensure the safety of employees, neighbours and the general public. Employees and visitors to the project site may be exposed to a variety of personal health and safety risks. The type and level of exposure is generally related to factors controlled by the employer/ developer. Such factors include design, equipment, tools, work procedures, project, and employee training. Occupational health and safety risks that should be considered by the employer arise from normal functions and operations and during unusual circumstances such as accidents and incidents. The employer/ developer is responsible for:

- Implementation of appropriate recognised OHS standards, practices and guidelines.
- Inclusion of meaningful participation of employees in implementation and maintenance of procedures and processes.
- Implementation of a programme to change employee culture and altitudes regarding health and safety.
- Planning, implementing and monitoring programs and as required to ensure OHS at the workplace.
- Provide and maintain workplaces, equipment, tools and machinery and organise work so as to eliminate or control hazardous ambient work factors.
- Provide appropriate occupational health and safety training for all employees.
- Provide adequate personal protective equipment to all employees at no cost to employees.
- Record and report occupational injuries and illness.
- Ensure contract specifications include demands for service providers, contractors, and sub-contractors to have or establish enabling them to meet the OHS requirements of the employer.

11.2 Occupational Health and Safety Management

It is hereby envisaged that an Occupational Health and Safety Management system (OHSMS) will be established, managed and operated for the proposed project. The system will contain the following features:

1. Occupational Health and Safety Policy for the company
2. Organizational framework of the OHSMS
   - ✓ Staffing of OHSMS
   - ✓ Competence requirements
   - ✓ Operating procedures
   - ✓ Training programs
   - ✓ Documentation
   - ✓ Communication
3. OHSMS objective (documentation)
4. Hazard prevention
   - ✓ Risk assessment
   - ✓ Prevention and control measures (active and negative)
   - ✓ Management of changes
   - ✓ Emergency preparedness and response
   - ✓ Procurement (tools, equipment, services, contractors)
5. Performance monitoring and measurements
   - ✓ Hazard prevention measures
   - ✓ Ambient working environment
   - ✓ Work related injuries, ill health, disease and injuries
6. Evaluation
   - ✓ Feedback
   - ✓ Corrective measures
   - ✓ Action plan

11.3 Employee safety

In addressing requirements and needs to ensure employee safety, the following will be in place: -

- Provision of adequate personal protective equipment.
- Enforcement and proper use of personal protective equipmnt by all employees.
- Provision of first aid and emergency services on site.
- Appropriate tools and equipment in sound working condition must be provided to employees to enable them work safely.

11.4 Safety of neighbours and general public

Project sites are associated with incidents and accidents that endanger neighbours and general public. The contractor must ensure the safety of all neighbours and the general public is taken care of by putting the following measures in place: -

- ✓ Vehicles and trucks tht will be ferrying in project equipment to the project site to observe required minimum speed limit when approaching the site to avoid accidents.
- ✓ There should be sign post prominently displayed at entry of project site with details of the project for information purpose.

11.5 Machine use and Electrical Safety

During project work, it is expected that different machines, tools and equipment will be used.
In regard to electrical safety, the following will have to be undertaken: -

- Installation and fitting of proper electrical appliances to enable supply of electrical energy to utility point.
- All electrical installations and fittings are done according to electrical safety rules.
- All electrical wires must be safely insulated.
- Sockets and other electrical outlets must be securely fitted.
- When not in use all machines should be shurt down.
- Qualified and well-experienced electrical engineers should be hired to carry out all electrical work.
- Safety slogans should be strategically posted as a reminder to employees.
- Operating manuals of equipment should be available for use whenever needed.

11.6 Internal Safety

During the entire project implementation and operation cycle, safety of the employees on the site should be taken care of. Some of the things that need to be in place include:-

- ✓ Emergency preparedness
- ✓ First aid
- ✓ Welfare facilities
- ✓ Personal protective equipment

11.7 First-Aid

i. Contractor to ensure qualified First Aiders are available to administer first aid to affected employees if need arises.

ii. An appropriately equipped First-Aid station to be easily accessible at the project site.. iii.A written Emergency Response Procedure to be in place.

11.8 Welfare facilities

- ✓ Changing rooms for workers to be provided.
- ✓ Shower rooms and washing facilities to be provided.
- ✓ Contractor to avail potable drinking water to all employees at site.
- ✓ Appropriate and adequate Personal Protective Equipment to be provided
- ✓ The enforcement on the consistence of the correct use of PPE provided
- ✓ The PPE provided to be maintained clean and replaced when damaged or worn out.

12. CONSULTATION AND PUBLIC PARTICIPATION

12.1 Introduction

Consultation with stakeholders that are likely to be affected and those that are likely to have an interest in the proposed project was conducted as provided for in Regulation 17 of the Environmental (Impact Assessment and Audit) Regulations, 2003. The consultation served to:-

- □Inform local community especially those drawn from the proposed project site of the proposed development within their locality.
- □Explain to the local community the nature of the proposed project, its objectives and scope.
- □Give local community especially those drawn from the proposed project site an opportunity to present their views, concerns and issues regarding the proposed.
- □Obtain suggestions from the local community and other stakeholders on possible ways potential negative impacts can be effectively mitigated and how the local community can be part of the proposed project.

12.2 Questionnaire survey

A questionnaire survey was carried out targeting to reach out to primary stakeholders at the grass root. (see the attached)

12.2.1 Stakeholders' Views, Issues and Concerns as captured in the questionnaire

- ✓ Getting more electricity into the national grid is a good idea, because it may help reduce power interruptions being experienced in the country.
- ✓ Setting up of wind turbines next to the ocean will interfere with the aquatic life and hence farmers may have a challenge finding fish.

- ✓ The blowing wind enhance by the blades of the wind turbines may have detrimental impacts on the environment especially the vegetation around may die off hence exposing the soil to the agents of erosion.
- ✓ The community has limited knowledge on the resultant impacts of the proposed wind farm project and thus the need to be educated for them to make an informed decision.
- ✓ The project as proposed has no direct benefit to the neighbouring community.
- ✓ The project is likely to facilitate more developmental in the area.
- ✓ The project will create employment for the community members.
- ✓ The proposed project could lead to noise pollution as a result of rotation of the blades of the numerous wing turbines to be installed.
- ✓ The proposed project is likely to create new knowledge and technological transfer to the community members especially those who will be directly involved in and students who will visit the project for educational purposes.
- ✓ The proposed project is limited to the environmental weather conditions, because of the unreliability of wing as a resource for power generation.
- ✓ The rate of school drop-outs in the area may go higher, hence the need to properly filter out those involved in the project.
- ✓ Wind energy is clean energy hence environmentally friendly.

12.2.2 Proposed measures to be put in place to address the issues and concerns as captured from the questionnaires

- ✓ Company needs to consider how it is going to help the community upgrade their living standards by supporting and strengthening the institutions around.
- ✓ Experts should be involved in the entire lifespan of the proposed project to check and mitigate any environmental concerns and impacts.
- ✓ Investor should engage the community fully before implementing the project to avoid conflict among them, the locals and authorities.
- ✓ Proponent, project implementers and other concerned parties should conduct educational and an awareness program among the community members before the project is implemented.
- ✓ The company should put in place a tree planting program with the necessary machinery of seeing to its success.
- ✓ The proponent and project implementers should factor in the stake of the neighbouring institutions and community in this project.

12. 3 Public Baraza

Public consultation through public meetings involved carrying out one public meetings within the neighbourhood of the proposed project site. Prior to conducting the public meetings official invitations and information letters was written to the target Groups.

- ✓ Corporate social responsibility of DSML should scale up to capture the entire catchment.
- ✓ Local community members to be given priority for employment in the project.
- ✓ The positive impacts from the proposed project should benefit local people first.
- ✓ Potential negative impacts should be mitigated appropriately.
- ✓ The local people should benefit from the electricity to be generated.


questioner filling

Locals agreed to support the project

13. ENVIRONMENT MANAGEMENT AND MONITORING PLAN

The Environmental (Impact Assessment and Audit) Regulations, 2003 define environmental management plan to mean ―all details of project activities, impacts, mitigation measures, time schedule, costs, responsibilities and commitments proposed to minimise environmental impacts of activities, including monitoring and environmental audits during implementation and decommissioning phases of a project‖. This environmental management and monitoring plan contains all the said components and also includes policies that the proponent needs to develop that will guide the implementation and operation of the proposed project as follows. Implementation of the proposed wind farm will require careful and sound environmental planning to ensure that potential negative impacts are appropriately mitigated for environmental conservation and sustainable development. To achieve this; the proponent should develop policies that will guide the operation of the proposed wind farm.

This environmental management and monitoring plan consist of the following:-

a) Company management policies
b) Potential positive impacts
c) Potential negative environmental impacts
d) Proposed mitigation measures
e) Action plans
f) Environmental monitoring
g) Conceptual decommissioning plan

13.1 Management policies

DSML will need to develop and document policies that will guide construction and operation of the proposed wind farm. The policies once developed will be vital in the following ways among others:

The policies once developed will be vital in the following ways among others:

- ✓ The policies will enable management to develop and maintain sound relations with all stakeholders.

- ✓ The policies will enable management put in place measures and structures that will care for the safety, health and welfare of all workers and the neighbouring community to the project site.
- ✓ The policies will provide a framework for management to plan for, and put in place, monitoring programmes that will ensure conservation and protection of the environment.
- ✓ The policies will provide a framework for management to assume its corporate responsibility for its activities with regard to conservation of the environment as well as for the well-being of the local community.

The proponent therefore should develop and document the following policies:-

a) Environmental Management Policy
b) Occupational Health and Safety Policy
c) Local Community Policy
d) Employment Policy

13.1.1 Environmental Management Policy

The environmental policy to be developed should be one that enables DSML to carry out company activities with the highest regard to the natural environment and sustainable utilisation of environmental resources therein. The policy should therefore cover the following, among other issues:-

- ✓ All legal requirements that will need to be complied during operation of the wind farm.
- ✓ Measures to be put in place to ensure continuous environmental improvement and performance through monitoring of wind farm activities.
- ✓ Ways to ensure that utilisation of natural resources is optimal with measures in place to ensure resource availability for future generation.
- ✓ Awareness creation to the surrounding community regarding sustainable utilisation of natural resources, protection of sensitive ecosystems and bio-diversity maintenance for communal livelihood.
- ✓ Balancing between natural resource use, environmental conservation and economic development.

13.1.2 Occupational Health and Safety Policy

The Occupational Health and Safety Policy to be developed should enable DSML put in place appropriate measures that will ensure that the health, safety and welfare of all employees is cared for; together with the health requirements of the local community The policy should highlight the following, among others:-

- ✓ Handling of turbines
- ✓ Wind farm safety
- ✓ Safety measures required for evacuation of generated electricity
- ✓ Appropriate safety and rescue equipment to be availed in all work places
- ✓ Emergency procedures and actions
- ✓ Risk minimisation of accidental damage to employees, community and environment
- ✓ Machine maintenance and machine operator proficiency ✓Training in safety.

13.1.3 Local Community Policy

The proponent to develop a Local Community Policy that ensures that the company develops and maintains sound relations with her employees and the local community on mutual respect and active partnership. The policy should highlight on ways the proponent should:-

- ✓ Work with the local community to achieve sustainable community development.
- ✓ Promote public awareness in regard to monitoring of developments site; potential environmental consequences to the area and the role of the local community.
- ✓ Propose ways of enhancing information flow from management to the community and employees, and vice visa.
- ✓ Community capacity building.
- ✓ Active engagement of the local community in the project.

13.1.4 Employment Policy

The Employment Policy to be developed by DSML should take into consideration the varying employment needs of the community. The policy should endeavour to protect the local community from unfair competition when it comes to recruitment of workers to work in the wind farm. The policy should cover the following, among other issues:-

- ✓ Local community considerations in employment.
- ✓ Training needs for employees.

- ✓ Employment of people with specialised skills.
- ✓ Casual Workers.
- ✓ Compensation, allowances and benefits.
- ✓ Terms of payment and scales.

13.2 Positive impacts of the proposed wind farm

13.2.1 Wind is clean, free, indigenous and inexhaustible

Wind turbines do not need any type of fuel to run, wind is freely locally availability and very renewable to appoint of one not able to exhaust it. Wind energy is a clean and environmentally friendly technology that produces electricity. Its renewable character and the fact it does not pollute during the operational phase makes it one of the most promising energy systems for reducing environmental problems at both global and local levels.

13.2.2 Reduced adverse environmental impacts associated with electricity generation

Wind energy has the capacity to reduce the adverse environmental impacts of other electricity energy generation sources. Generation of electricity by wind energy has the potential to reduce environmental impacts, because unlike generators that use fossil fuel, it does not result in the generation of atmospheric contaminants or thermal pollution. Wind energy reduces the need for electricity generation using other sources of energy, it can reduce the adverse environmental impacts of those sources, such as production of atmospheric and water pollution, including greenhouse gases; production of nuclear wastes; degradation of landscapes due to mining activity; and damming of rivers.

13.2.3 Contribution to climate change mitigation

Generation of electricity from wind energy contribute zero greenhouse gases emission and reduces dependency on energy sources that result in greenhouse gas emission thus reducing the overall greenhouse gases emitted from electricity generation to meet the needs of the county. Not only generation of electricity from wind produce zero emissions of carbon dioxide (during the operational phase) but it also does not release toxic pollutants (for example mercury) or conventional air pollutants (for example smog-forming nitrogen dioxide and acid rain-forming sulphur dioxide). Generation of electricity from wind energy source contributes to climate change mitigation through the reduction of greenhouse gases. Wind

energy has a key role to play in combating climate change by reducing CO_2 emissions from power generation. The emergence of international carbon markets, which were spurred by the flexible mechanisms introduced by the Kyoto Protocol as well as various regional emissions trading schemes such as the European Union Emissions Trading Scheme (EU ETS), could eventually provide an additional incentive for the development and deployment of renewable energy technologies and specifically wind energy.

13.2.4 Availability and applicability

Wind energy is widely applicable because wind resources are available in most countries unlike other renewable energy resources such as geothermal that are limited to certain areas and regions. Renewable energies such as wind are also much more sustainable than conventional power sources. In addition, they can help provide a more secure supply of energy, they can be competitive economically, and they can be both regional and local. Wind energy is playing an important role in helping nations reach Kyoto Protocol targets

13.2.5 Does not use other natural resources

Wind power does not make use of natural resources like oil, gas or cause and therefore will not cause damage to the environment through resource transportation and extraction and also do not need consequent amounts of water during operation

13.2.6 Avoided emissions and external costs

In general, the benefits of wind energy are avoided emissions and avoided external costs as compared with conventional, mainly fossil fuel-based, electricity generation. A comparison of social costs of different electricity generation technologies indicates that a kWh of wind energy presents a negligible external cost in comparison with fossil fuel-based power systems. This fact illustrates the social and environmental advantages of wind energy and other renewables over conventional energy systems. Consequently, it is desirable to increase wind energy and other renewables in the electricity supply systems.

13.3 Potential Negative Impacts from the Proposed Wind Farm

13. 3.1 Introduction

A wind farm uses wind turbines to convert wind energy into electricity; the output power of a turbine is the function of the density of the air, the area swept by the turbine blades, and the cube of the wind speed (Ellenbogen, *et. al*., 2012). The primary environmental issues related to wind turbine usage include wildlife safety, bio-system disturbance, noise, visual impacts, electromagnetic interference, and local climate change (Lima et. al., 2013; Tabassum-Abbasi *et. al*., 2014). These issues can be grouped into ecological effects, impacts on humans, and climate-related issues (National Research Council. 2007; Mann and Teilmann 2013).

13.3.2 Impact identification and predication

The type, scale and location of the project guided the scope of the impact identification. The direct and indirect project-related impacts on the environment and local community and residual impacts were considered during the assessment of impacts. The extent of impact can be limited to the project site and to specific activity at particular period, or affect areas beyond the project site. Duration in which the impact takes place is also considered in the evaluation of the impact. The period can be specific to the period of certain activities or could be related to the occupancy period of the project development. Thus, in terms of duration an impact can be viewed as a short, medium, long term impact or permanent. Impact can affect biodiversity partially or completely. For instance only small part of habitat, ecological processes or small population of species can be destroyed by the impact. Thus, magnitude of an impact was evaluated as proportion of the environmental entity affected. The probability of the impact to happen was derived from the frequency of the activity and frequency of impacts. The four characteristics described above were used to synthesise significance of the impact as shown in impact significance assessment criteria(figure 23) that is used to generatethe risk assessment matrix (table 13).

EXTENT

Localized (At localized scale and a few hectares in extent)	1
Study area (The proposed site and its immediate environs)	2
Regional (District and provincial level)	3
National (Country)	4
International (Beyond Kenya)	5

MAGNITUDE

Small and will have no effect on the environment	0
Minor and will not result in an impact on the processes	2
Low and will cause a slight impact on the processes	4
Moderate and will result in process continuing but in a modified way	6
High (processes are altered to the extent that they temporarily cease)	8
Very high and results in complete destruction of patterns and permanent cessation of the processes	10

DURATION

Very short (0 – 1 Years)	1
Short (1 – 5 Years)	2
Medium term (5 – 15 years)	3
Long term (>15 years)	4
Permanent	5

PROBABILITY

Highly improbable (<20% chance of occurring)	1
Improbable (20 – 40% chance of occurring)	2
Probable (40% - 70% chance of occurring)	3
Highly probable (>70% - 90% chance of occurring)	4
Definite (>90% chance of occurring)	5

Figure 23: Impact significance assessment criteria

Table 13: Risk assessment matrix

		CONSEQUENCE (Extent+Duration+Magnitude)																			
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
PROBABILITY	**1**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	2	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
	3	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	4	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80
	5	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

NOTE 1: Risk = Consequence x Probability

NOTE 2: Consequence = Extent + Duration + Magnitude

NOTE 3: Confidence assessment (low, medium and high) based on combination of available information and expert judgement

Low impact (<30) this impact would not have a direct influence on the decision to develop in the area

Medium impact (30-60) the impact could influence the decision to develop in the area unless it is effectively mitigated

High impact (>60) the impact must have an influence on the decision process to develop in the area

13.4 Potential negative impacts during construction phase

Potential negative impacts likely to result from implementation of the proposed wind farm may include the following:-✓Impacts on terrestrial flora

- ✓ Air quality impact - Noise and vibration
- ✓ Air quality impacts - Particulate matter emission
- ✓ Impacts on terrestrial fauna
- ✓ Occupational injuries
- ✓ Traffic inconvenience along Mombasa-KWALE Road
- ✓ Waste generation

13.4.1 Impacts on terrestrial flora

Implementation of the proposed wind farm will involve clearing and removal of vegetation at the site where the wind turbine will be erected and allied infrastructure such as transformer and cabling system. The footprint of land to be cleared for wind turbine installation includes the area required for the staging of heavy equipment and large turbine parts. Survey of terrestrial flora at the proposed project site for the current study indicate that the proposed project site has vegetation that includes *Ricinus communis, Phyllanthus reticulatus*; *MimusopsobtusifoliaAdansonia digitata, Cassytha filiformis, Azidiracta indica, Striga gesnerioides,* which will have to be cleared to create room for excavation works for appropriate anchorage of the turbine. Clearing of vegetation on site will result in overall loss of vegetation from the site. Vegetation on site has both ecological and environmental roles, vegetation loss will result in loss of both environmental and ecological services derived from these vegetation. The confidence of assessment of these impacts when unmitigated based on the risk assessment matrix is as tabulated in table 14.

Table 14: Unmitigated impacts on terrestrial flora

Extent of impact	1
Magnitude of impact	4
Duration of impact	2
Probability of impact	4
Risk = (Extent + Magnitude + Duration) x Probability	28
Confidence of Assessment	Low impact

13.4.2 Air quality impact – Construction phase noise and vibration

The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 define noise to mean ―any undesirable sound that is intrinsically objectionable or that may cause adverse effects on human health or the environment‘ and noise pollution to mean _the emission of uncontrolled noise that is likely to cause danger to human health or damage to the environment‖. The Factories and OtherPlaces of Work (Noise Prevention and Control) Rules, 2005 on the other hand define noise to mean ―all sound energy which can result in hearing impairment or be harmful to health or otherwise dangerous‖. The construction phase of the proposed wind farm project will involve undertaking various activities that can be a potential source of noise. The activities will include site preparation for site accessibility, haulage of the structural portions of a wind turbine (tower, blades, hub, nacelle, rotor, and transformer), construction of concrete bases to

anchor the assembled turbines, trenching works for underground transmission lines to the sub-station, the actual erection of the turbines and central control room are a potential source of noise during the construction phase. Potential noise receptors during the construction phase may include construction workers and staff of Mombasa Cement Vipingo who will be at the vicinity of the proposed project site. Noise generation during the construction phase however will be limited to the duration of project construction. Potential negative impacts of such noise may include impaired oral communication among the staff involved in the construction activities resulting in shouting and laud talking among themselves when communicating, reduced concentration and annoyance to neighbours. The confidence of assessment of these impacts when unmitigated based on the risk assessment matrix is as tabulated in table 15

Table 15: Unmitigated construction phase noise and vibration impacts

Extent of impact	1
Magnitude of impact	4
Duration of impact	2
Probability of impact	4
Risk = (Extent + Magnitude + duration) x Probability	28
Confidence of Assessment	Low impact

13.4.3 Air quality impacts - Particulate matter emission

According to the International Standardization Organization (ISO 4225 - ISO, 1994), dust is ―small solid particles, conventionally taken as those particles below 75 µm in diameter, which settle out under their own weight but which may remain suspended for some time". The Glossary of Atmospheric Chemistry Terms (IUPAC, 1990) define dust as small, dry, solid particles projected into the air by natural forces, such as wind, volcanic eruption, and by mechanical or man-made processes such as crushing, grinding, milling, drilling, demolition, shovelling, conveying, screening, bagging, and sweeping. Dust particles are usually in the size range from about 1 µm to 100 µm in diameter, and they settle slowly under the influence of gravity." Some of the activities during the construction phase of the proposed wind farm may provide favourable conditions for dust generation while other activities may generate dust. Activities which are likely to generate favourable conditions for dust generation may

including clearance of vegetation at the proposed project site, excavations works on site, equipment movement on excavated open areas devoid of vegetation. Considering the site is along the coast line with favourable windy conditions, regular sea breezes will easily blow loss soil particles on the opened ground projecting them into the air. Use of cement which is powdery in nature, ballast with loose particles and coral building blocks to construct concrete bases will potentially generate dust. Dust generated during the construction phase will be minimal and much limited to the construction activity area. Potential receptor of the dust will be construction workers, adjacent flora and fauna to the site. Potential negative impacts of the dust may include chocking of respiratory tract if inhaled, skin irritation when contact with skin, limiting evapotranspiration of plants when it settles on plant leaves, inhibiting stomata functioning for plants, covering of plant leaves resulting in green depigmentation of plants that affects plant photosynthetic activities resulting in reduced plant growth and development. The confidence of assessment of these impacts when unmitigated based on the risk assessment matrix is as tabulated in table 16.

Table 16: Unmitigated construction phase dust impacts

Extent of impact	1
Magnitude of impact	4
Duration of impact	2
Probability of impact	4
Risk = (Extent + Magnitude + duration) x Probability	28
Confidence of Assessment	Low impact

13.4.4 Impacts on terrestrial fauna

Terrestrial fauna survey at the proposed project site for the current study indicate that terrestrial fauna at the proposed project site include insect pollinators such as butterflies and bees, herpetiles (reptiles snakes, lizards, geckos puff adder and black mamba) and amphibians (frogs and toads). Implementation of the proposed project may affect site terrestrial fauna negatively by causing shrinkage of their habitat, reduction and or loss of their feeding areas, reduction and or loss of nesting areas, potential noise and vibration disturbance from the proposed project may affect feeding and reproduction pattern and equipment activity

on site may result in trampling on fauna on site resulting in their mortality. The confidence of assessment of these impacts when unmitigated based on the risk assessment matrix is as tabulated in table 17.

Table 17: Unmitigated impacts on terrestrial fauna

Extent of impact	1
Magnitude of impact	4
Duration of impact	2
Probability of impact	4
Risk = (Extent + Magnitude + Duration) x Probability	28
Confidence of Assessment	Low impact

13.4.5 Occupational safety and health impacts

During the construction phase of the proposed wind farm project various activities will be undertaken such as site clearance, ground excavation, trenching, and construction of concrete bases. Considering that undertaking of these activities will involve the use of heavy equipment such as excavators, loaders, and cranes among others; and that some of the work will involve working at height and working in confined areas such as in trenches. Such a working environment coupled with the use of such working equipment may potential be a source of occupational accidents, injuries, misses and near misses at the workplace. Negative impacts that may arise from the said potential sources of occupational accidents, injuries, misses and near misses at the workplace may include injuries to workers at the workplace, loss of productive workforce, loss of man-hours, reduced productivity, delays in project implementation and litigations. The confidence of assessment of these impacts when unmitigated based on the risk assessment matrix is as tabulated in table 18.

Table 18: Unmitigated impacts of construction phase occupational safety and health

Extent of impact	1
Magnitude of impact	4
Duration of impact	2

Probability of impact	3
Risk = (Extent + Magnitude + Duration) x Probability	21
Confidence of Assessment	Low impact

13.4.6 Traffic inconvenience along Mombasa-Nairobi Road

As envisaged for the proposed project, parts of the wind turbines to be installed at the proposed project site will be transported to the site via the Mombasa-Nairobi highway. Considering the turbine parts are heavy and bulky in nature and require heavy equipment for their installation the proposed turbines will thus be transported as abnormal cargo via road Mombasa-Nairobi road to the proposed site. This may be a course of inconveniences to other road users in the section of Mombasa-Nairobi highway up to the turnoff to Devki Site inSamburu site. The inconveniences may include traffic delays to other motorist among, requirement for other motorists to give way to the load being transported, such delays can result in traffic pileup along the said section of the road, it can be a potential course of accidents and injuries to pedestrians, motorists and other road users along the said section of the road. The confidence of assessment of these impacts when unmitigated based on the risk assessment matrix is as tabulated in table 19.

Table 19: Unmitigated traffic impacts

Extent of impact	3
Magnitude of impact	4
Duration of impact	1
Probability of impact	3
Risk = (Extent + Magnitude + Duration) x Probability	24
Confidence of Assessment	Low impact

13.4.7 Waste generation

Waste will be generated during the construction phase, operational phase and decommissioning phase of the wind farm. During the construction phase waste will be generated from ground preparation in readiness for installation of the turbines and associated infrastructure for the wind farm. This waste will include vegetation/ plant matter that will be cut and removed and excavated overburden rock/ soil material. Other wastes may include waste paper from use of cement (empty cement bags), fastening, wrapping and packaging material (wooden pallets, carton boxes, polythene materials, nylon). Waste likely to be generated from servicing of construction equipment may include waste oil, empty containers of lubricants and absorbent material. Waste that may be generated from operational phase may include waste resulting from damage of turbines and other allied wind farm infrastructure while waste likely to be generated from decommissioning phase may include waste derived from wind turbines that have reached their end-of-service lives. Waste generated from the three phases may potentially affect the environment negatively if the waste is not handled and disposed appropriately.

13.5 Potential negative impacts during operational phase

13.5.1 Introduction

Wind-energy development may influence ecosystem structure and functioning through direct impacts on individual organisms and through impacts on habitat structure and functioning (Jaber, 2013). Environmental influences of wind-energy facilities can propagate across a wide range of spatial scales, from the location of a single turbine to landscapes, regions, and the planet, and a range of temporal scales from short-term noise to long-term influences on habitat structure and influences on presence of species (Miles and Odell 2004). The ecological influences of wind-energy facilities are complex, and can vary with spatial and temporal scale, location, season, weather, ecosystem type, species, and other factors (Jaber, 2013). The influences can be cumulative and ecological; can interact in complex ways at wind energy facilities and at other sites associated with changed land-use practices and other anthropogenic disturbances (Lechón Y and Oltrawww.wind-energy-thefacts.org/documents/download). The construction and maintenance of wind-energy facilities can contribute to alteration of ecosystem structure through vegetation clearing, soil

disruption and potential for erosion, and noise (Jaber, 2013). Likely potential negative impacts from the implementation of the proposed wind farm during the operation phase may include visual impacts, noise disturbance, impacts on avifauna and bats, reception of radio waves and weather radar electromagnetic interferences and local climate change - Impact on local weather and regional climate.

13.5.2 Visual impacts

The view-shed or visual footprint of a wind farm that is the area within which the wind farm is visible determines the visual impacts of a wind farm. The characteristics of the proposed turbines i.e. size, height, number, material and colour; access and site tracks, substation buildings, compounds, grid connection, and transmission lines; may cause landscape and visual effects. The turbines to be used in the proposed wind farm project will be eighty meters tall making them inherently tall, with large rotor-swept areas making them potentially visible over long distances. Such a wind farm can be an eyesore and hence result in visual intrusion. A visual impact, unique to wind farms, is shadow flicker, which can be a problem when turbines are located relatively close to homes or businesses, creating an annoying effect of rapidly blinking shadows when the sun is near the horizon. Visual impact decreases with the distance zone of theoretical visibility for the proposed wind farm can be defined as follows:

- ✓ Zone I – Visually dominant: the turbines are perceived as large scale and movement of blades is obvious. The immediate landscape is altered. Distance up to 2 km.
- ✓ Zone II – Visually intrusive: the turbines are important elements on the landscape and are clearly perceived. Blades movement is clearly visible and can attract the eye. Turbines not necessarily dominant points in the view. Distance between 1 and 4.5 km in good visibility conditions.
- ✓ Zone III – Noticeable: the turbines are clearly visible but not intrusive. The wind farm is noticeable as an element in the landscape. Movement of blades is visible in good visibility conditions but the turbines appear small in the overall view. Distance between 2 and 8 km depending on weather conditions.
- ✓ Zone IV – Element within distant landscape: the apparent size of the turbines is very small. Turbines are like any other element in the landscape. Movement of blades is generally indiscernible Distance of over 7 km.

Table 20: Unmitigated visual impacts

Extent of impact	2
Magnitude of impact	4
Duration of impact	4
Probability of impact	5
Risk = (Extent + Magnitude + Duration) x Probability	50
Confidence of Assessment	Medium impact

13.5.3 Noise disturbance

Wind turbines produce two types of noise: mechanical noise from gearboxes and generators (turbine hum‖ from inside the nacelle), and aerodynamic noise from blades (—rotor swish‖ from air movement around the rotor blades). Whereas the design of modern wind turbines have virtually eliminated the mechanical noise through good insulation materials in the nacelle, aerodynamic noise is the biggest contributor of noise from wind farms. The aerodynamic noise is produced by the rotation of the blades generating a broad-band swishing sound and it is a function of tip speed. The noise within or around a wind farm will vary considerably depending on a number of factors including the layout of the wind farm, the particular model of turbines installed, the topography or shape of the land, the speed and direction of the wind, and the background noise. The factors with the most influence on noise propagation are the distance between the observer and the source and the type of noise source. The sound emissions of a wind turbine increase as the wind speed increases. However, the background noise will typically increase faster than the sound of the wind turbine, tending to mask the wind turbine noise in higher winds. Sound levels decrease as the distance from the wind turbines increases.

Noise receptors from the proposed wind farm include the neighbouringThe proponent will undertake Noise measurement annually.

Table 21: Unmitigated noise disturbance

Extent of impact	2

Magnitude of impact	6
Duration of impact	4
Probability of impact	5
Risk = (Extent + Magnitude + Duration) x Probability	60
Confidence of Assessment	Medium impact

13.5.4 Impacts on avifauna and bats

Bird mortality caused by wind farms seems to be a sporadic event and dependent on different elements such as the season, the specific site, the species and the type of bird activity. Birds that use the proposed project site for roosting, feeding, nesting, and migratory route can potentially be killed by collisions with wind turbines. Groups of birds of concern in terms of collisions with wind turbines are seabirds, migratory species, and grassland birds with aerial flight displays. Bats are more vulnerable to wind turbine mortality than most birds; scientific research shows that bats tend to be killed by wind turbines at significantly higher rates than birds. The significantly higher mortality for bats has to do with the fact that: for reasons that are still poorly understood, bats appear to be attracted to wind turbines (rather than simply encountering them by chance, as birds do), and unlike birds, bats can be killed just by closely approaching an operating wind turbine without even touching it, due to lung damage from rapid decompression (barotrauma). Species of birds that use the proposed project site that are likely to be negatively affected from the proposed project site may include different assemblages of birds from various feeding guilds and families such as grassland birds, wetlands birds, waterbirds, and woodland birds. Species sited in the area include Winding cisticola, House crow, Ethiopian swallow, Little swifts, Grassland Pipit, Pin-tailed Whydah, African Palm-swift, Black-crowned Tchagra, Wire-tailed Swallow, White-browed Coucal among others.

Bird mortality due to collision with wind turbine and associated wind farm infrastructure can be caused by various reasons including light emitted from wind farms which attracts birds especially at night and during foggy weather (Mario *et al*., 2010), prevailing weather conditions that influence the height at which the birds will fly (Gregory, 2000), the height of

flight of birds (Sarah and Ellen, 2007) and the design of the wind farm (Magoha, 2003). During poor weather and foggy conditions birds become disoriented, the disorientation results in the disoriented birds being attracted to light emitted from wind farm which leads to the increasing number of avian fly through wind farm and their vulnerability from collision with wind turbine blades. Prevailing weather conditions tend to influence the height of flight of migrant birds. Although migrating birds generally fly at altitudes higher than 150 m, migrants tend to fly lower during heavy overcast weather such as high winds, low clouds, and rain. This increases the birds‘ potential of flying through the wind turbines, and hence increasing chance of collision. Issues of concern of design of wind turbine that potentially can contribute to bird collision and hence their mortality include wind turbine designs that have lower hub heights and shorter rotor diameters can cause the blades to spin at high revolutions per minute hence increasing chances of bird collision, turbines that have the lattice towers tend to attract nesting of birds farther increasing their potential to collide with the blades as they try to nest, farther tighter/ close spacing of turbines on the ground will increase chances of birds colliding with the spinning blades when the birds are flying through the wind farm. The confidence of assessment of these impacts when unmitigated based on the risk assessment matrix is as tabulated in table 22.

Table 22: Unmitigated impacts on avifauna and bats

Extent of impact	5
Magnitude of impact	6
Duration of impact	4
Probability of impact	4
Risk = (Extent + Magnitude + Duration) x Probability	60
Confidence of Assessment	Medium impact

13.5.5 Reception of radio waves and weather radar electromagnetic interferences

Scientific research has shown that wind farms when operational have the potential for electromagnetic interference with television and radio broadcasting, cellular phones, and

radar (Jaber, 2013). Radar is a system for detecting the presence or position or movement of objects by transmitting radio waves, which are reflected back to a receiver. The radio wave transmitted by radar can be interrupted by an object (also called a target), and then part of the energy is reflected back (called echo or return) to a radio receiver located near the transmitter. Wind turbines are vertical structures that can potentially interfere with certain electromagnetic transmissions. Mobile structures such as rotating blades may generate more interference on the radars than stationary structures. The effects depend on type of radar, specific characteristics of wind turbines and the distribution of wind turbines. Operational wind turbines tend to interfere with the signals received by radar and telecommunications systems, including aviation radar, radio, television, and microwave transmission. These potential impacts are likely to be significant when the wind turbines are within the line-ofsight of the radar or telecommunications facility (Ledec, *et al*., 2011). Reception of radio waves and weather radar electromagnetic inferences will be of potential concern for Rea Vipingo Air strip and Vipingo Ridge Airstrip. The confidence of assessment of these impacts when unmitigated based on the risk assessment matrix is as tabulated in table 23.

Table 23: Unmitigated impacts on reception of radio waves and weather radar electromagnetic inferences

Extent of impact	2
Magnitude of impact	4
Duration of impact	4
Probability of impact	2
Risk = (Extent + Magnitude + Duration) x Probability	20
Confidence of Assessment	Low impact

13.5.6 Local climate change - Impact on local weather and regional climate

Scientific studies have shown that wind turbines can impact on local weather and regional climate (Zhou *et al*, 2012). The impact can include increase in local temperature, (Wang and Prinn, 2010), however, this warming effect caused by wind turbines is still much weaker than

that generated by the emission of greenhouse gases on the global scale (Dai, *et al.,* 2015). Other effects include change in distribution of rainfall and clouds (Dai, *et al.,* 2015) and increase in precipitation (Wang and Prinn, 2010). The turbulence created by wind turbine blade rotations can affect the regional climate as well. Research work has documented that the cooling effects during daytime and the warming effects at night for large wind farms are the direct results of the vertical air mixture near the ground surface. In a stable atmosphere where a warm air layer overlies a cool air layer, the vertical mixing can blow the warm air down and the cold air up, leading to a warm ground surface. On the other hand, in an unstable atmosphere with a negative lapse rate, the vertical mixing can push the cool air down and the warm air up, resulting in a cooling effect near the ground surface (Roy and Traitor, 2010). Therefore, wind farms altered the regional climate; a regional climate change can induce change in regional weather patterns (Dai, *et al.,* 2015). The confidence of assessment of these impacts when unmitigated based on the risk assessment matrix is as tabulated in table 24

Table 24: Unmitigated impacts on climate change

Extent of impact	2
Magnitude of impact	2
Duration of impact	4
Probability of impact	2
Risk = (Extent + Magnitude + Duration) x Probability	16
Confidence of Assessment	Low impact

13.6 Potential negative impacts during decommissioning phase

Once the wind farm is out of service, the work of dismantling the turbines and the transportation from the erection area to the final disposal site. Potential negative impacts during decommissioning phase may include the following.

- ✓ Injuries and accidents
- ✓ Noise
- ✓ Waste related impacts

13.7 Proposed Mitigation Measures for Identified Potential Negative Impacts

Table 25: Proposed mitigation measures

POTENTIAL NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURE
Construction phase	
Impacts on terrestrial flora and fauna- vegetation clearing Establishing rows of wind turbines with inter-connecting roads will involve the clearing of vegetation which will destroy local fauna habitats, destroy vegetation and displace local fauna	- Careful site selection for the wind farm and associated transmission lines to avoid or minimize the clearing vegetation and destruction of associated fauna habitats. - Configuring wind turbines and access roads to minimize the clearing of vegetation and destruction of associated fauna habitats. - Limit vegetation clearance and removal to actual location/installation of the turbine and allied infrastructure. - Avoid off-road driving by wind farm personnel that can result in destruction of flora and fauna on site
Noise and vibration	- Limit the construction and turbine installation to day time. - Ensure equipment like heavy duty cranes being used to install the turbines are appropriately serviced and maintained.

	- Put in place a comprehensive noise and vibration conservation programme which will include noise and vibration level monitoring, use of noise attenuators, training and use of appropriate personal protective equipment - Ensure the provisions of Environmental Management and Coordination (Noise and excessive vibration control) Regulation, 2009 are adhered to.
Particulate matter (dust) emission	- Regular sprinkle water on opened up dusty access roads - Secure construction site with dust screens - Provide construction workers with appropriate personal protective devices - Monitor dust levels. - Ensure the provisions of the Environmental Management and Coordination (Air Quality) Regulations 2014 are adhered to.
Occupational injuries	- Ensure only skilled and experienced workers are involved in the construction of the wind farm and allied infrastructure. - Ensure suitable, appropriate, well serviced and maintained equipment are availed to the workers. - Workers working at height and in confined areas must be provided

	with appropriate safety equipment. - An all equipped first aid station to be on site with trained and experienced first aiders, stand by ambulance and referral hospital. - Ensure that the provisions of the Occupational Safety and Health Act, 2007 are adhered to.
Traffic inconvenience along Mombasa-KWALE Road	- Permission to be sought from Kenya National Highway Authority for transportation of abnormal loads (wind turbines) prior to transportation. - An escort vehicle one in front and one behind the truck transporting the turbines to be provided. - Turbines to be transported during daylight only. - Notice to be issued on local press of transportation of abnormal loads on the said road to inform other potential road users on order for them to exercise extra caution.
Operational phase	

Visual impacts- some people consider large wind turbines to be an eyesore. Shadow flicker:This is a specialized type of visual impact, in which spinning wind turbines create an annoying effect of rapidly-	- Thorough stakeholder engagement, including prior consultation, participatory decision-making, and information disclosure and dissemination.
blinking shadows when the sun is near the horizon.	- Appropriate site selectionto avoid areas used for tourism and recreation. - Adjusting the location of turbine rows or individual turbines to reduce perceived visual impacts. - Choose wind power equipmentwith aesthetics in mind (where consistent with other objectives), such as a smaller number of (larger) turbines and reduced or different night lighting. - Careful site selectionto locate turbines where they would not produce shadow flicker around human dwellings. - Use planning tools—standard industry software that predicts the location and timing of shadow flicker. - Stakeholder engagementwith potentially affected households and businesses.

	- Create a visually balanced, simple and consistent image by adopting a regular wind turbine tower layout format such as a double line, a triangle, or a grid for regular landscapes such as an open or levelled space as is the case of the proposed project site. - Turbine colours to be white, off-white or grey which gives

	people a feeling of cleanliness and efficiency and engage the turbines to the backdrops at different views and in different weather conditions. - Design of wind farm according to the peculiarities of the site and with sensitivity to the surrounding landscape. - Locate the wind farm at least reasonable distance from dwellings. - Selection of wind turbine design (tower, colour) according to landscape characteristics; - Selection of neutral colour and anti-reflective paint for towers and blades. - Underground cables

	- Lights for low-altitude flight only for more exposed towers.
Noise disturbance - Wind turbines produce bothmechanical noise (turbine hum) andaerodynamic noise (rotor swish), which humans readily notice within300 m or so.	- Careful site selectionto locate turbines an adequate distance from human dwellings. - Use planning Tools—standard industry software that predicts specific noise impacts on nearby buildings. - Stakeholder engagementwith potentially affected households and businesses.

	- Improved blade design to reduce the aerodynamic noise by decreasing rotational speeds to under 65 m/s at the tip; and using pitch control on upwind turbines, which permits the rotation of the blades along their long axis - Application of upwind turbines to reduce low frequency noise. - Use of special gearboxes for wind turbines instead of standard industrial gearboxes. Steel wheels of the special gearbox have semi-soft and flexible cores with hard surfaces to ensure strength, to extend the lifetime of the equipment, and to muffle noise.

	- Consider direct drive wind turbines without any gearbox or high-speed mechanical component which operate more quietly or variable-speed turbines which create less noise at low wind speeds than the constant-speed turbines.
Impacts on avifauna and bats - bird and bat mortality Birds collide with spinning wind turbines; and power transmission lines. Bird species groups of special concern include raptors, seabirds, migratory species, and birds with aerial flight displays. Bat mortality occurs when bats collide with spinning turbines or closely approach	- Careful site selection to avoid building wind farm within important bird habitats and bird migration routes. - Bird flight activities in a zone of 200-500 m surrounding the planned wind farm should be recorded and analysed. Fight heights, directions, species, and behaviours of birds -

them, causing lung damage from decompression.	should be studied systematically. - Restrict construction activities to non-breeding periods for avifauna to help reduce the negative effects of bird disturbance. - Structural design improvements to reduce bird mortality by enlarging the blades and slowing the rotational speed of the turbines. - Pattern paint the blades to increase the visual acuity of raptors.

	- Provide night illumination by lighting the turbine tower to improve blade visibility at night to reduce bird and bat collision with turbine towers at night - Increased turbine cut-in speed (which is the lowest wind speed at which the rotor blades are spinning and generating electricity for the grid) to minimise bat mortality. - Short-term shutdowns (in which the rotor blades do not turn during peak migration events) to minimise bird motarlity - The direction of tower layout should be properly designed to reduce the effects on bird migration.
Reception of radio waves and weather radar electromagnetic interferences- Operating wind turbines can interfere with the signals	- Careful site selectionto avoid installing turbines within the line-of-sight of radar or telecommunications facilities.
received by radar andtelecommunications systems, including aviation radar, radio, television, and microwave transmission. These impacts tend to be significant when wind turbines arewithin the line-of-sight of the radar or telecommunications facility	- Consider using turbine blades made from synthetic materials, which produced less electromagnetic interference compared to steel blades. Install deflectors or repeaters to overcome the problem of already existing wind turbine induced electromagnetic interference. -

Local climate change	- Careful site selection for location of wind farm to ensure the wind farm is located in regions where wind energy is abundant and the frictional dissipation is high in this way, the wind energy will be harvested instead of losing as frictions. - Rotor generated turbulences to be reduced through improved rotor and blade designs and a proper design of turbine spacing and pattern.
Blade throw- This is the risk of a loose rotor blade being thrown as a result of severe mechanical failure.	- Careful site selectionto locate turbines an adequate distance from human dwellings - Timely servicing and maintenance of the turbines as per manufacturer‘s schedule.

Decommissioning phase

Injuries and accidents	- Ensure that the provisions of the Occupational Safety and Health Act, 2007 are adhered to. - Ensure only skilled and experienced workers are involved in the decommissioning of the wind farm and allied infrastructure. - Ensure suitable, appropriate, well serviced and maintained equipment are availed to the workers. - Workers working at height and in confined areas must be provided with appropriate safety equipment. - An all equipped first aid station to be on site with trained and experienced first aiders, stand by ambulance and referral hospital.
Noise and vibration	- Limit the dismantling of the turbines and allied infrastructure to day time. - Ensure equipment used in the decommissioning of the entire wind farm are appropriately serviced and maintained. - Put in place a comprehensive noise and vibration conservation programme which will include noise and vibration level

	monitoring, use of noise attenuators, training and use of appropriate personal protective equipment

	- Ensure the provisions of Environmental Management and Coordination (Noise and excessive vibration control) Regulation, 2009 are adhered to.
Dust	- Regular sprinkle water - Secure decommission site with dust screens - Provide decommissioning workers with appropriate personal protective devices - Monitor dust levels - Ensure the provisions of the Environmental Management and Coordination (Air Quality) Regulations 2014 are adhered to.
Waste generation	- Ensure all the waste generated in handled and disposed as provided for in the Environmental Management and Coordination (Waste Management) Regulations, 2006. - Explore possibility of re-use and or recycling

13.8 Action plans

Table 26: Biodiversity management action plan

Issue/ concern	Potential negative impacts	Proposed mitigation measures	Monitoring	Responsible actors	Timeframe	Annual Budget (KSH)

Vegetation clearing	- Loss of local vegetation - Loss of habitat for local fauna - Displacement and or destruction of local fauna	- Careful site selection for the wind farm and associated transmission lines Configuring wind turbines and - access roads to minimize the clearing of vegetation Limit -	- Physical checks/ sports checks during implementatio n Ensuring that wind farm - personnel follow environmental rules of conduct as during construction	Responsible DSML Wind Farm Manager	Mitigation measures to be put in place from beginning of project implementation and be sustained and improved on throughout the project cycle.	300,000

Issue/ concern	**Potential negative impacts**	**Proposed mitigation measures**	**Monitoring**	**Responsible actors**	**Timeframe**	**Annual Budget (KSH)**

		vegetation clearance and removal to actual location/installation of the turbine and allied infrastructure				
Operation of the wind farm	-Bird mortality through collision with spinning wind turbines; and power transmission	- Short-term shutdowns, in which the rotor blades do not turn during peak migration events of birds	- Postconstruction monitoring of bird and bat mortality Records of wind farm -	DSML Directors, Responsible DSML Wind Farm Manager, wind farm staff, conservation groups	Mitigation measures to be put in place from beginning of project implementation and be sustained	5,000,000
Issue/ concern	**Potential negative impacts**	**Proposed mitigation measures**	**Monitoring**	**Responsible actors**	**Timeframe**	**Annual Budget (KSH)**

	lines. -Bat mortality by colliding with spinning turbines or closely approach them, causing lung damage from decompression	- Diligent equipment maintenance such as capping holes in wind turbine nacelles can help prevent unnecessary bird mortality For bats, the most important turbine operation is to increase in cutin speed -	equipment maintenance		and improved on throughout the project cycle	

Table 27: Noise and vibration management action plan

Issue/Activity	Potential negative impacts	Proposed mitigation measures	Monitoring	Responsible actors	Timeframe	Annual Budget
Construction of the wind farm	- Noise nuisance to construction workers - Noise nuisance to workers of the adjacent DSML cement factory	- Limit the construction to day time - Appropriately service and maintain construction equipment - Put in place a comprehensiv e noise and vibration conservation programme - Ensure the	-Quarterly noise monitoring against the documented benchmarked noise level prior to project commenceme nt	DSML Directors, Responsible DSML Wind Farm Manager, wind farm staff,	Mitigation measures to be put in place from beginning of project implementation and be sustained and improved on throughout the project cycle.	500,000

Issue/Activity	Potential negative impacts	Proposed mitigation measures	Monitoring	Responsible actors	Timeframe	Annual Budget
		provisions of Environmental Management and Coordination (Noise and excessive vibration control) Regulation, 2009 are adhered to				
Operation of the wind farm	- Noise nuisance to neighbours - Noise	- Improved blade design to reduce the aerodynamic	- Quarterly noise monitoring against the	DSML Directors, Responsible DSML Wind Farm Manager, wind	Mitigation measures to be put in place from beginning of	500,000

Issue/Activity	Potential negative impacts	Proposed mitigation measures	Monitoring	Responsible actors	Timeframe	Annual Budget

	nuisance to maintenance staff - Noise nuisance to visitors to the wind farm	noise by decreasing rotational speeds to under 65 m/s at the tip; and using pitch control on upwind turbines, which permits the rotation of the blades along their long axis - Application of	documented benchmarked noise level prior to project commencement - Feedback from the neighbours - Feedback from maintenance crew	farm staff	project implementation and be sustained and improved on throughout the project cycle	

Issue/Activity	Potential negative impacts	Proposed mitigation measures	Monitoring	Responsible actors	Timeframe	Annual Budget
		upwind turbines to reduce low frequency noise - Use of special gearboxes for wind turbines instead of standard industrial gearboxes. Steel wheels of the special gearbox have semi-soft and				

Issue/Activity	Potential negative impacts	Proposed mitigation measures	Monitoring	Responsible actors	Timeframe	Annual Budget
		flexible cores with hard surfaces to ensure strength, to extend the lifetime of the equipment, and to muffle noise. - Use of direct drive wind turbines without any gearbox or high-speed				

Issue/Activity	Potential negative impacts	Proposed mitigation measures	Monitoring	Responsible actors	Timeframe	Annual Budget
		mechanical component which operate more quietly or variablespeed turbines which create less noise at low wind speeds than the constantspeed turbines				
Decommissioning of the wind farm	- Noise nuisance to workers undertaking	-Limit the dismantling of the turbines and allied	- noise monitoring against the documented	DSML Directors, Responsible DSML Wind Farm Manager, wind	During decommissioning period	500,000

Issue/Activity	Potential negative impacts	Proposed mitigation measures	Monitoring	Responsible actors	Timeframe	Annual Budget

	decommissioning work - Noise nuisance to neighbours	infrastructure to day time - Ensure equipment used in the decommissioning of the entire wind farm are appropriately serviced and maintained - Put in place a comprehensiv e noise and vibration	benchmarked noise level during decommissioning - Feedback from the neighbours - Feedback from decommissioning crew	farm staff		
Issue/Activity	**Potential negative impacts**	**Proposed mitigation measures**	**Monitoring**	**Responsible actors**	**Timeframe**	**Annual Budget**

		conservation programme				

Table 28: Occupational injuries management action plan

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
Working at height and in confined places	- Injuries resulting from falling from elevated work areas	-Ensure only skilled and experienced workers are involved in the construction of the wind farm and allied infrastructure.	- Injury records - Feedback from workers	DSML Directors, Responsible DSML Wind Farm Manager, wind farm staff,	Mitigation measures to be put in place from beginning of project implementation and be sustained	500,000

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
		- Ensure suitable, appropriate, well serviced and maintained equipment are availed to the workers. - Workers working at height and in confined areas must be provided with appropriate safety				

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)

		equipment. - An all equipped first aid station to be on site with trained and experienced first aiders, stand by ambulance and referral hospital. - Ensure that the provisions of the				

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
		Occupational Safety and Health Act, 2007 are adhered to				
Dust	- Chocking of respiratory tract if inhaled - skin irritation when contact with skin - limiting evapotranspiration of plants when it settles	- Regular sprinkle water on opened up dusty access roads - Secure construction site with dust screens - Provide	- Physically checking plants around the construction area for dust deposition on leaves - Feedback from workers	DSML Directors, Responsible DSML Wind Farm Manager, wind farm staff	Mitigation measures to be put in place from beginning of project implementation and be sustained	100,000

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)

	on plant leaves - inhibiting stomata functioning for plants - Covering of plant leaves resulting in green depigmentatio n of plants that affects plant photosynthetic activities	construction workers with appropriate personal protective devices - Monitor dust levels. - Ensure the provisions of the Environmental Management and Coordination				

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
	resulting in reduced plant growth and development	(Air Quality) Regulations 2014 are adhered to.				
Noise and vibrations	-	- Limit the construction and turbine installation to day time. - Ensure equipment like heavy duty cranes being used to install the turbines are	- Feedback from neighbours - Noise and vibration measurement	DSML Directors, Responsible DSML Wind Farm Manager, wind farm staff	Mitigation measures to be put in place from beginning of project implementation and be sustained	300,000

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)

		appropriately serviced and maintained. - Put in place a comprehensive noise and vibration conservation programme which will include noise and vibration level monitoring, use of noise attenuators,				

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
		training and use of appropriate personal protective equipment -Ensure the provisions of Environmental Management and Coordination (Noise and excessive vibration				

Issue/concern	Potential negative impacts	Proposed mitigation measures	Environmental monitoring	Responsible actors	Timeframe	Cost estimate (KSH)
		control) Regulation, 2009 are adhered to.				

Table 29: Waste management action plan

Issue/concern	Potential negative impact	Proposed mitigation measure	Monitoring	Responsible actors	Timeframe	Budget
Generation of solid waste	- Pieces of plastics can lead to avian and marine life choking through consuming partially broken down pieces of plastic, and being strangled by discarded plastics	Waste to be managed and disposed as per EMC (Waste Management) Regulations, 2006	- Records of waste disposed - Tracking documents of waste disposal	- DSML Directors, Responsible DSML Wind Farm Manager, wind farm staff - Environmental Officer for DSML	Mitigation measures to be put in place from beginning of project implementation and be sustained	500,000

Issue/concern	Potential negative impact	Proposed mitigation measure	Monitoring	Responsible actors	Timeframe	Budget
	- increase the risk of flooding by clogging storm drains and other areas which can eventually cause flooding					

13.9 Monitoring and Audit

13.9.1 Monitoring

13.9.1.1 Active monitoring

Active monitoring will include:

- Monitoring of the achievements of specific plans of the EMP, performance criteria and fulfilment of objectives.
- Systematic inspection of work place.
- Surveillance and monitoring of the work environment, including the organization of work and activities involved.
- Monitoring of workers‘ health.
- Monitoring of compliance with laws, regulations and other requirements.

13.9.1.2 Reactive monitoring This

would include:

- Work related injuries, ill health (including record keeping and monitoring of sickness/absence), disease and accidents.
- Losses such as damage to property.
- Safety and health performance.

13.9.2 Environmental audit

Environmental Audit will be carried out as provided for in the Environmental (Impact Assessment and Audit) Regulations of 2003. The Audits will serve to confirm the efficacy and adequacy of the proposed Environmental Management Plan. The audits should include but not limited to the following.

- ✓ Waste generation, management and disposal
- ✓ Views and comments from neighbours
- ✓ Progress in implementation of Environmental Management Plan.

13.10 Decommissioning plan

Decommissioning is the last phase of project life; it involves terminating project activities and operations and rehabilitating site to or close to its original state. Decommissioning of a project which is still under implementation can be necessitated if it is declared unsafe. Natural calamities such as earthquakes and tremors may destabilize a project necessitating its decommissioning.

13.10.1 Components

This decommissioning plan presents a conceptual framework on how the proposed wind farm and allied infrastructure can be decommissioned and how the site can be rehabilitated.

13.10.2 Decommissioning of the entire project

Decommissioning of the wind farm and allied infrastructure will involve dismantling of the wind turbines and all allied infrastructure. Project proponent should seek written approval from NEMA on the intention to decommissioning prior to decommissioning. To ensure safe handling and disposal of resulting waste from the turbines and other components of the wind farm at the end of the useful life it is important that the suppliers and or manufacturers of the turbines and allied infrastructure be involved in the decommissioning, handling and disposal of resulting waste.

13.10.3 Site rehabilitation

Once decommissioning of the various components of the wind farm and allied infrastructure is complete rehabilitation of affected site should be undertaken to its original state or close to original state. Site rehabilitation will include the following: -

- ✓ Test and analysis of soil from site should be undertaken before rehabilitation begins.
- ✓ Any contaminated soil should be decontaminated first prior to farther progress.
- ✓ Planting of appropriate species of trees paying attention to the species of trees that were previously in the site before the project.
- ✓ Ensuring they are regularly watered, weeded in their early stages to ensure survival.
- ✓ The area should be fenced off while rehabilitation is in progress to avoid damage to tender trees planted.

14. FINDINGS CONCLUSIONS AND RECOMMENDATIONS

14.1 Findings

The following are the key findings:-

- ✓ The proposed project site is owned by Devki Steel Mills Limited is the proponent,
- ✓ Whereas the proponent is involved in mining of limestone for clinker and cement production, the proposed location of the proposed wind farm is a reserve for limestone deposits for future use.
- ✓ The proposed location of the wind farm is a fairly clear and flat terrain hence making equipment mobilization relatively easily.
- ✓ The proposed wind farm will consist of twelve Vistas V-90 wind turbines each 3 megawatts.
- ✓ The proponent is yet to either procure or independently collect wind data for the site however what is so far informing the project in terms of wind potential is a wind speed information and annual energy production calculation report based on Modern Era Retrospective-analysis for Research and Applications (MERRA) from NASSA and the National Climatic Data Centre (NCDC) of the USA,
- ✓ The proponent is yet to carry out a detailed design of the wind farm, currently the proponent has prepared preliminary draft design which will be continuously be improved on as the proposed project advances.
- ✓ There is an existing power transmission grid complete with a sub-station at close proximity to the proposed wind farm site making the proposed wind farm more economical to undertake.
- ✓ The electricity to be generated from the proposed wind farm is intended to be sold to the national grid under the Feed-In-Tariff Policy for wind developed by the Ministry of Energy and Petroleum.
- ✓ Envisaged positive impacts from the proposed wind farm may include provision of affordable clean, indigenous and reliable energy, minimisation of reliance of conventional, mainly fossil fuel-based electricity generationmethods that emit greenhouse gasses, contribution to climate change mitigation among others.

- ✓ This assessment established that the proposed wind farm may have negative impacts on local avifauna, other fauna, flora, local aesthetics in terms of visual impacts, bring about issues of noise among others.
- ✓ Appropriate mitigation measures for all identified negative impacts have been proposed. It is envisaged that once these mitigation measures are put in place the identified negative impacts will be adequately addressed.

14.2 Conclusion

Notwithstanding the potential negative impacts from the proposed project, there exist mitigation measures of identified potential negative impacts as outlined in this study report. Farther management can also borrowing a leave from existing similar project in Kenya and from elsewhere in the world.

14.3 Recommendations

- ✓ Management to undertake a geotechnical study of specific location of each turbine prior to installation.
- ✓ The management to finalise preparation a detailed design of the proposed wind farm
- ✓ Necessary approvals to be applied for and obtained from Kenya Civil Aviation prior to project implementation.
- ✓ The environmental management plan proposed to be fully implemented during the operational phase of the proposed project.
- ✓ Annual monitoring of avifauna and bats to be undertake during project operational life.

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16. LIST OF APPENDICES

Appendix 1 Certificate of land titles, certificates of postal search, and letters of parcels of land

Appendix 2 copy of the certificate of incorporation and copy of personal identification number certificate

Appendix 3 Copy of letter of acknowledgement from NEMA of receipt of the project report

Appendix 4 Certificates of registration and practicing licence of the Lead Experts

Appendix 5 Wind speed information and annual energy production calculation report

Appendix 6 Questionnaire survey responses

Appendix 7 Baraza attendance list and minutes of proceedings from the Baraza