STRATEGIC ENVIRONMENTAL ASSESSMENT FOR WIND POWER AND BIODIVERSITY IN KENYA

DRAFT REPORT

30 JULY 2019

VERSION 1.1 – FOR STAKEHOLDER REVIEW

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Proponent: Ministry of Energy

Lead Expert: Dr Mwangi Githiru – The Biodiversity Consultancy

Tier: Plan-level

ABOUT THIS REPORT

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Technical work has been carried out by The Biodiversity Consultancy (TBC) in partnership with BirdLife International, Nature Kenya, and The Peregrine Fund (collectively, the Kenya Bird Conservation Consortium) and additional support from Habitat Info, Maasai Mara University, National Museums of Kenya, North Carolina Zoo and the University of Utah.

DISCLAIMER

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SEA IMPLEMENTATION TEAM

Lead expert

Dr Mwangi Githiru – The Biodiversity Consultancy

Technical oversight and co-ordination

Dr Leon Bennun – The Biodiversity Consultancy

Steering group

Dr Paul Matiku – *Nature Kenya*

Dr Kariuki Ndang'ang'a – *BirdLife International*

Dr Munir Virani – *The Peregrine Fund*

Data compilation

Vincent Onyango, Alex Ngari and Kariuki Ndang'ang'a – *BirdLife International*

Frank Juma – National Museums of Kenya (waterbird counts)

Dr Paul Webala – Maasai Mara University (bats)

Data analysis and mapping

Tris Allinson, Mark Balman, Ben Jobson – *BirdLife International*

Bat surveys

Dr Paul Webala, Christabel A. Ochieng, Simon Wafula – *Maasai Mara University*

Raptor surveys and vulture tagging

Darcy Ogada, Martin Odino, Martin Kahindi, Peter Wairasho – *The Peregrine Fund*

Vulture tracking and vulture movement analysis

Dr Corinne Kendall – North Carolina Zoo

Dr Darcy Ogada, Dr Munir Virani – *The Peregrine Fund*

Dr Evan Buechley – *University of Utah*

Dr Rob Davies – *Habitat Info*

Policy review and analysis

Serah Munguti, John Kiptum, Dr Paul Matiku – *Nature Kenya*

Technical and project management support

Amy Burden, Edward Pollard, Dr David Wilson – *The Biodiversity Consultancy*

Paul Gacheru – *Nature Kenya*

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2 LIST OF ABBREVIATIONS

AFD	Agence Française de Développement (French Development Agency)
AMDA	Africa Mini-grid Developers Association
BL	BirdLife
BLAPS	BirdLife Africa Partnership Secretariat
CBD	Convention on Biological Diversity
CITES	Convention on International Trade in Endangered Species of Wild Fauna
CMS	Convention on Migratory Species
COD	Commercial Operation Date
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act
EMMP	Environmental Management and Monitoring Plan
ERC	Energy Regulatory Commission
ESA	Environmentally Significant Area
ESH	Extent of Suitable Habitat
ESIA	Environmental and Social Impact Assessment
ESMAP	Energy Sector Management Assistance Program
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FPIC	Free, Prior and Informed Consent
GDC	Geothermal Development Company
GT	Gas Turbines
GWA	Global Wind Atlas
IBA	Important Bird Area
IREK	Innovation and Renewable Electrification in Kenya
IRENA	International Renewable Energy Agency
IPP	Independent Power Producer
IUCN	International Union for the Conservation of Nature
KBA	Key Biodiversity Area
KenGen	Kenya Electricity Generation Company
KEPSA	Kenya Private Sector Alliance
KEREA	Kenya Renewable Energy Association
KETRACO	Kenya Electricity Transmission Company Limited
KNBS	Kenya National Bureau of Statistics

KOSAP	Kenya Off-Grid Solar Access Project
KPGTMP	Kenya’s Power Generation and Transmission Master Plan
kWh	Kilowatt hour
kWp	Kilowatt peak
LAC	Limits of Acceptable Change
LCPDP	Least Cost Power Development Plan
MoE	Ministry of Energy
MSD	Medium Speed Diesel
NEMA	National Environment Management Authority
NK	Nature Kenya
NMK	National Museums of Kenya
OEM	Original Equipment Manufacturer
PESTEL	Political, Economic, Social, Technological, Environmental and Legal
PLF	Plant Load Factor
PPA	Power Purchase Agreement
PPP	Policies, Plans & Programs
REA	Rural Electrification Authority
SEA	Strategic Environmental Assessment
SE4All	Sustainable Energy for All
SWERA	Solar and Wind Energy Assessment
TBC	The Biodiversity Consultancy
TPF	The Peregrine Fund
UNIDO	United Nations Industrial Development Organization
VEC	Valued Environmental Component
WPD	Wind Power Density
WTG	Wind Turbine Generator

3 GLOSSARY

Term	Description or definition
Annual energy output	If you know a turbine's capacity and efficiency factors, you can compute its estimated annual energy output using the following formula: (365 days per year) times (24 hours per day) times (maximum capacity) times (capacity factor) equals expected kilowatt hours per year. For example, a turbine with a rated capacity of 1.5 megawatts and efficiency factor of 25 percent would be expected to produce as follows: 365 * 24 * 1,500 (kW) * .25 = 3,285,000 kilowatt hours per year. This calculation assumes wind availability at 24 hours a day all year around. In practical application, this doesn't happen and needs to be adjusted depending on location.
Average wind speed	Wind speeds are usually measured at a height of 10 metres, every 10-minutes, in order to be compatible with most standard software. The wind variation for a site is usually described using the Weibull distribution. Since the statistical distribution of wind speed varies from place to place around the globe, depending upon local climate conditions, the landscape, and its surface, the Weibull distribution may thus vary, both in its shape, and in its mean value. The mean wind speed is the average of the wind speed observations from a given site
Barotrauma	Barotrauma involves tissue damage to air-containing structures caused by rapid or excessive pressure change; pulmonary barotrauma is lung damage due to expansion of air in the lungs that is not accommodated by exhalation. The decompression hypothesis proposes that bats are killed by barotrauma caused by rapid air-pressure reduction near moving turbine blades. It has been assumed in the past that barotrauma causes bat fatalities at wind farms, but this is not proven and is increasingly thought to be unlikely
Capacity factor	See Plant Load Factor below
Energy auction	An auction is a selection process designed to procure (or allocate) goods and services competitively, where the award is made to a bidder based on a financial offer. As a general proposition, auctions are a means to match energy supply with demand in a cost-effective manner
Feed-in tariff	A Feed-in Tariff allows power producers to sell generated electricity to an off-taker at a pre-determined tariff for a given period. It is a policy strategy that aims to increase investment in renewable energy technologies such as wind, bio-mass, geo-thermal, solar etc.
Hub height	The wind turbine hub height is the rotor's height above ground. Hub heights typically range between 25m (for smaller wind turbines, 50 kW or less) and 100m (for large, multi-megawatt wind turbines); Vestas have recently built a turbine with a hub height of 165m. In general, wind turbine energy production increases with the hub height, but so does the cost

Term	Description or definition
kWh & kWp	kWh (kilowatt hour) is the power produced by a wind turbine or solar panel kWp (kilowatt peak) is the power that a wind turbine or solar panel generates under standard conditions, corresponding to the power that the turbine or panel generates during the best wind or sun conditions of the year
Mini-grid	Mini-grids are defined as small, privately-owned and operated systems with generation of less than 10 megawatts (MW) capacity and a network that distributes power to multiple customers. Very small mini grids of less than 1 kilowatt (kW) capacity are sometimes referred to as 'micro' or 'pico' grids. Mini-grids can provide electricity at the local level using isolated distribution networks or be connected to a central grid
Plant Load Factor	PLF refers to the ratio between the actual energy generated by the turbine to the maximum possible energy that can be generated while working at its rated power for a designated duration. Also known as the capacity factor, it is the average power generated, divided by the rated peak power. For example, if a five-megawatt wind turbine produces power at an average of two megawatts, then its capacity factor is 40% (2÷5 = 0.40, i.e. 40%)
Valued Environmental Component	A valued ecosystem component (VEC) is an element of the environment that has scientific, economic, social or cultural significance. VECs can also be defined as fundamental elements of the physical, biological or socio-economic environment, including the air, water, soil, terrain, vegetation, wildlife, fish, birds and land use that may be affected by a proposed project. Those VECs that may be affected by a project's activities are included in environmental assessments
Wind power class	The wind power class of a wind turbine is a rating system that is used to rank the quality of the location of a wind turbine and the average wind speed of that location. The higher the wind power class number, the more acceptable the site location will be for a wind turbine project. In general, commercial wind power development is considered to become feasible around wind power class 4
Wind power density	WPD is a quantitative measure of wind energy available at any location. It is the mean annual power available per square meter of swept area of a turbine, and is calculated for different heights above ground. Calculation of wind power density includes the effect of wind velocity and air density. It is a calculation relating to the effective force of the wind at a particular location, frequently expressed in terms of the elevation above ground level over a period of time. It considers wind velocity and mass
Wind speed	Wind speed is a crucial factor when deciding the power class of a wind turbine. Wind speed is usually measured in meters per second for rating wind turbine locations. The higher the wind speed, the greater the wind power class rating

4 NON-TECHNICAL EXECUTIVE SUMMARY

4.1 CONTEXT

This non-technical summary outlines the key findings and mitigation measures of the Strategic Environmental Assessment (SEA) for Wind Energy and Biodiversity in Kenya. Strategic environmental assessment (SEA) is a pro-active decision support instrument in policy, plan, and programme (PPP) making or implementation. It aims at making strategic decisions above the project level more transparent, accountable and ultimately more environmentally sustainable. SEA examines and identifies ways to avoid, reduce or otherwise mitigate negative impacts while enhancing positive outcomes.

This SEA is designed to support the general wind development sector in Kenya, specifically by helping integrate biodiversity considerations into decisions that relate to wind power development. The SEA was undertaken by a consortium of biodiversity experts on behalf of the Ministry of Energy (MoE). This summary starts by briefly describing the SEA methodology, followed by the main findings and recommendations.

Energy is one of the key enablers of the Vision 2030 and energy security remains a matter of national priority. Towards this end, the Government of Kenya is working to ensure universal access to modern energy services, planning to double the global rate of improvement in energy efficiency and double the share of renewable energy (RE) in the national energy mix by 2030.

Kenya's objective is to increase the country's installed electricity capacity to c. 7,200 MW by 2030 from the current capacity of c. 2,200 MW, with wind and solar increasingly prominent in this new generation mix. The greater emphasis on wind and solar, both on and off grid, will support Kenya's climate change mitigation commitments, and also reduce wood fuel dependence and ameliorate the serious environmental pressures this creates.[1]

Over the years the Government has been involved in medium to long term planning of the energy sector through the annual 20-year rolling Least Cost Power Development Plan (LCPDP). The last published one was the 2011-2031 Plan, with a draft 2017-2037 in-place. The LCPDP is meant to identify existing potential in generation, possible investments in transmission as well as carefully forecasting on future demand for power and how best it can be met at least cost. In 2013, the Ministry of Energy and Petroleum (MOEP) undertook the development of a Power Generation and Transmission Master Plan (PGTMP) for Kenya, which produced the Long-Term Plan (LTP) for the period 2015 to 2035. This LTP entailed an identification and analysis of suitable expansion paths of the Kenyan power system for that period.

4.1.1 AIMS

In the right places, wind power is a clean, green energy source with low environmental impacts. In the wrong places, wind power can be a serious threat to biodiversity, especially flying species of birds and bats. Understanding where such conflicts could arise is thus crucial to planning for wind power development. Recent growth in wind energy generation has led to concerns over the effect of this development on wildlife around the world. Investigations of impacts to flying species are conducted at many wind energy facilities,

[1] e.g. https://www.seforall.org/sites/default/files/Kenya_AA_EN_Released.pdf

yet there remains a paucity of knowledge regarding the effects on species at the national and regional level. The key strategic goal for this SEA is environmental. It is aimed at assessing the biodiversity-related impacts of wind energy development nationally, considering current, planned and potential projects, to ensure that the developments are aligned with the relevant PPPs and to consider strategic alternatives. Thus, the overarching goal is to enhance positive opportunities and minimise any negative risks of wind power development.

4.1.2 SCOPE

The broad scope of the work is to carry out SEA for wind power development and biodiversity in Kenya. Geographically therefore, this Plan SEA has a national scope, but is entirely focused on onshore wind power development. Offshore wind energy, while growing in importance globally, is not part of current energy development plans in Kenya and was not considered as part of this SEA.

Temporally, the SEA is based on the latest approved Least Cost Power Development Plan 2011-2031, other candidate or ongoing wind power development projects included in the KPGTMP (2015) and draft LCPDP 2017-2037, and potential projects outlined in the 2013 Wind Sector Prospectus (WinDForce 2013). The thematic scope of this wind power SEA is biodiversity, with a focus on birds and bats.

Thus, while this is a Plan SEA primarily founded upon the wind power-related elements of the LCPDP 2011-2031, it will take a national perspective beyond the projects under the LCPDP, in order to respond to wind energy plans outlined in other important national policies and legislation around renewable energy expansion. The SEA specifically targets wind power and biodiversity, with a focus on flying species (birds and bats) as these have been shown to be most at-risk from wind power development, especially associated with turbines (e.g., Diffendorfer et al. 2015).

4.2 APPROACH AND METHODOLOGY

Strategic Environmental Assessments vary depending on the type of SEA (Policy, Plan or Programme) and sector under consideration. This SEA followed the 2012 National Guidelines for SEA in Kenya and international good practice. The methods employed involved a desk study of critical literature on the subject matters (wind power and biodiversity), field work to fill in any data gaps and enhance sensitivity mapping and modelling, and stakeholder consultations to collect and discuss major wind power development issues touching biodiversity conservation.

The SEA methodology we employed thus took into consideration three key sources of information for the biodiversity aspects analysed in the SEA:

- **Experts' workshop and fieldwork**: The biodiversity (birds and bats) sites and species data provided by experts or that were collected in the field during the course of this assessment;
- **Stakeholders' views** gathered through a fully inclusive and transparent stakeholder engagement as required by NEMA. This ensured that all relevant stakeholders were aware of and involved (if they wished to be) in the SEA process, and that their concerns were incorporated into the analysis and recommendations;
- **Desk research**: Secondary research on the energy-related and environmental Policies, Plans, Programmes (PPPs) and strategies of the Government of Kenya and of the key stakeholders, and how these affect the proposed wind development plans in the LCPDP. Further wind energy issues such as new technological advancements and biodiversity concerns were studied from published sources from other countries with a more-advanced wind power sector.

4.2.1 STAKEHOLDER CONSULTATION

Stakeholder participation at all levels is integral to the successful development and future implementation and monitoring of the SEA. This wind power SEA was designed as a highly participatory process to allow government agencies, civil society, wind-power developers and other affected stakeholders multiple opportunities for contributing to the process and final product.

4.2.1.1 SCOPE FOR STAKEHOLDER ENGAGEMENT

Geographically, the scope of the SEA is national and stakeholder engagement was focused at that level. Technically, the scope for the stakeholder consultations focused on wind energy development and biodiversity, particularly birds and bats.

4.2.1.2 STAKEHOLDER MAPPING, ANALYSIS AND IDENTIFICATION

For biodiversity, the SEA expert technical consortium used their prior knowledge to identify key stakeholders in Kenya, particularly bird and bat experts, across NGOs, Universities and Government. In addition to the SEA consortium members, bird experts were drawn from the National Museums of Kenya (NMK) and public universities including Egerton University, while bat experts were also drawn from NMK and Masai Mara University. For wind power development, the Plan owner (the Ministry of Energy working with associated state agencies, especially the ERC) was supported by USAID's Power Africa Transactions and Reform Programme to undertake a stakeholder analysis for the wind development sector. Stakeholders identified included government authorities and state corporations in the environment and energy sectors, civil society and private sector agencies (both investors and wind power developers).

The stakeholder engagement and communication plan was built around the following key steps, in alignment with NEMA Guidelines:

- **Biodiversity Expert Workshop**: for identification of key species and sites (Valued Environmental Components) as well as gaps in knowledge.
- **Government engagement process**: for mainstreaming of the process and settling on the primary owner and user of the final product.
- **Scoping stage consultative workshop**: for identification of key issues to be addressed under the SEA, plus further analysis and segmentation of major stakeholders across the wind development sector.
- **Consultative stakeholder meeting** to gather stakeholder input on the 'zero draft' of the SEA report and its key findings.

The process from here will follow NEMA guidance via:

- Public comments on Draft SEA report: internal (NEMA) and external stakeholder engagement for detailed comments on the draft SEA Report. To ensure that public engagement is meaningful and not just a case of providing stakeholders with detailed information, the SEA engagement process requires that these comments are checked by NEMA and incorporated into the Final SEA, which is cross-checked during the validation workshop.
- Validation workshop: full stakeholders' workshop for presenting the final version of the SEA Report.

4.2.2 STAKEHOLDER ENGAGEMENT AND VIEWS

Summary outcomes from the three workshops are outlined below:

4.2.2.1 BIODIVERSITY EXPERT WORKSHOP

The workshop at National Museums of Kenya on 13 March 2018 identified Valued Environmental Components (VECs) for species and sites, which were subsequently further reviewed and consolidated for the SEA. VECs are the key species and sites on which the SEA would focus, considering potential sensitivity to wind power impacts (based on conservation status and risk of collision), and their occurrence and distribution in Kenya.

For birds, most raptors and vultures were considered at high risk due to their soaring behaviour, migratory and congregatory tendencies and fast flights; owls were considered generally low-risk. Other bird species like waterbirds and cranes were considered at moderate to high risk, especially if they were migratory

For bats, four groups were considered most at-risk: fruit bats, sheath-tailed bats, free-tailed bats and long-fingered bats. This was due to a combination of their flying, foraging, roosting and migratory behaviours

For sites, the key sites considered as VECs were based on topography (cliffs and scarps), nesting and roosting sites (including caves for bats), IBAs/KBAs, wetlands and migratory bottlenecks.

4.2.2.2 CONSULTATIVE SCOPING WORKSHOP

This scoping-stage workshop held at Norfolk Hotel on 22 August 2018 aimed to obtain initial thoughts and feedback from key stakeholders about the proposed SEA, and to identify industry needs and any major gaps. A total of 43 participants attended across ten stakeholder categories: national government (both energy and environment sectors), county government, NGOs, investors and lenders, wind power developers, consultants, academia, aviation sector, and media.

Ten key issues pertaining to wind energy and biodiversity were raised, with several points pertaining to the scope of the proposed SEA: these were responded to and agreed upon during the workshop and/or addressed in the content of the Scoping Report.

4.2.2.3 CONSULTATIVE MEETING ON SEA FINDINGS

The second consultative workshop (National Museums of Kenya, 12 March 2019) was convened to discuss the key results from the zero draft of the Full Report. The main objectives of this meeting were (i) to update sector players on progress that the SEA Team had achieved, (ii) to present key findings from the study and initial recommendations of the draft wind power and biodiversity SEA, and (iii) seek input from sector players on the zero draft SEA, particularly to help with consolidating recommendations.

Fifty-four participants attended this meeting held at the National Museums of Kenya, from a diverse array of stakeholder categories. Some 25 key issues, questions and reactions were raised during the workshop which were addressed both during the meeting and subsequently incorporated into the revised Full SEA Report, including a major additional analysis of findings at county level.

4.2.3 REVIEW OF WIND POTENTIAL AND PLANS

Growing concerns about the negative impacts of fossil fuel use coupled with advances in renewable technology have initiated a major transformation of energy systems around the globe. Wind energy is one of the fastest developing energy technologies across the globe, with numerous efforts to harness wind energy on a utility scale, and technology advancements bringing down generation costs. Wind power is in a rapid transition to becoming a fully commercialized, unsubsidized technology, successfully competing in the marketplace against other sources.

Kenya has among the highest potentials for wind power in Africa and is already experiencing a surge in wind power project development. The 300 MW Lake Turkana Wind Power project is the largest single wind farm in Africa, while the 5.1 MW Ngong Hills Wind Farm was expanded in 2016 to 25.5 MW. Some 20 additional projects, totalling around 900 MW of additional capacity, are currently in the pipeline.

The Government of Kenya undertakes medium to long term planning of the energy sector through the 20-year rolling Least Cost Power Development Plan (LCPDP) The last published one was the 2011-2031 Plan, with a draft 2017-2037 plan in review. The LCPDP is meant to identify existing potential in generation, and possible investments in transmission, as well as carefully forecasting on future demand for power and how best it can be met at least cost. In addition, in 2013, the then Ministry of Energy and Petroleum (MOEP) commissioned the development of a Power Generation and Transmission Master Plan (PGTMP) for Kenya, which produced the Medium- and Long-Term Plans for the periods 2015-2020 and 2015-2035, respectively.

This is a Plan-level Strategic Environmental Assessment (SEA), primarily aligned to the wind power-related elements of the Least Cost Power Development Plan (LCPDP) – 2011-2031. However, in addressing the growing need and commitment to wind power development in Kenya, the SEA goes beyond the projects under this LCPDP in order to incorporate other important plans and policies around renewable energy expansion in Kenya, such as the Kenya's Power Generation and Transmission Master Plan. It takes a national perspective in order to respond to wind energy plans outlined in other important national policies and legislation around renewable energy expansion. The SEA specifically targets wind power and biodiversity, with a focus on flying species (birds and bats) as these have been shown to be most at-risk from wind power development, especially associated with turbines.

Based on the 2011-2031, draft 2017-2037 LCPDPs and MoE data, the total installed generation capacity for Kenya grew by 77% from 2010 to a total of over 2700 MW in 2018, made up of c. 30% Hydro, 30% Thermal, 25% Geothermal, 12% Wind, 2% Solar and 1% Biomass. According to the long-term Master Plan, Kenya's objective is to increase the country's installed capacity to > 6,800 MW by 2030, then to > 9,500 MW by 2035, in line with predicted growth in peak load. Wind power's contribution to this total is expected to rise from 26 MW (1.2%) in 2015 to 720 MW (10.5%) by 2030 and 1,150 MW (12.1%) by 2035.

The existing wind power plants include the Ngong Hills KenGen projects that were developed and commissioned in three stages: Ngong 1, Phase I: 5 MW; Ngong 1, Phase 2: 6.8 MW; and Ngong 2: 13.6 MW. The 310 MW Lake Turkana Wind Power project has recently come on stream. Close to 20 additional wind projects, totalling around 900 MW of additional capacity, are currently in development. The most recent modelling of wind power density nationally, from the World Bank's Global Wind Atlas, is shown in Figure 4-1. Figure 4-2 shows locations of current, planned and potential wind power projects in Kenya, along with current and proposed transmission lines.

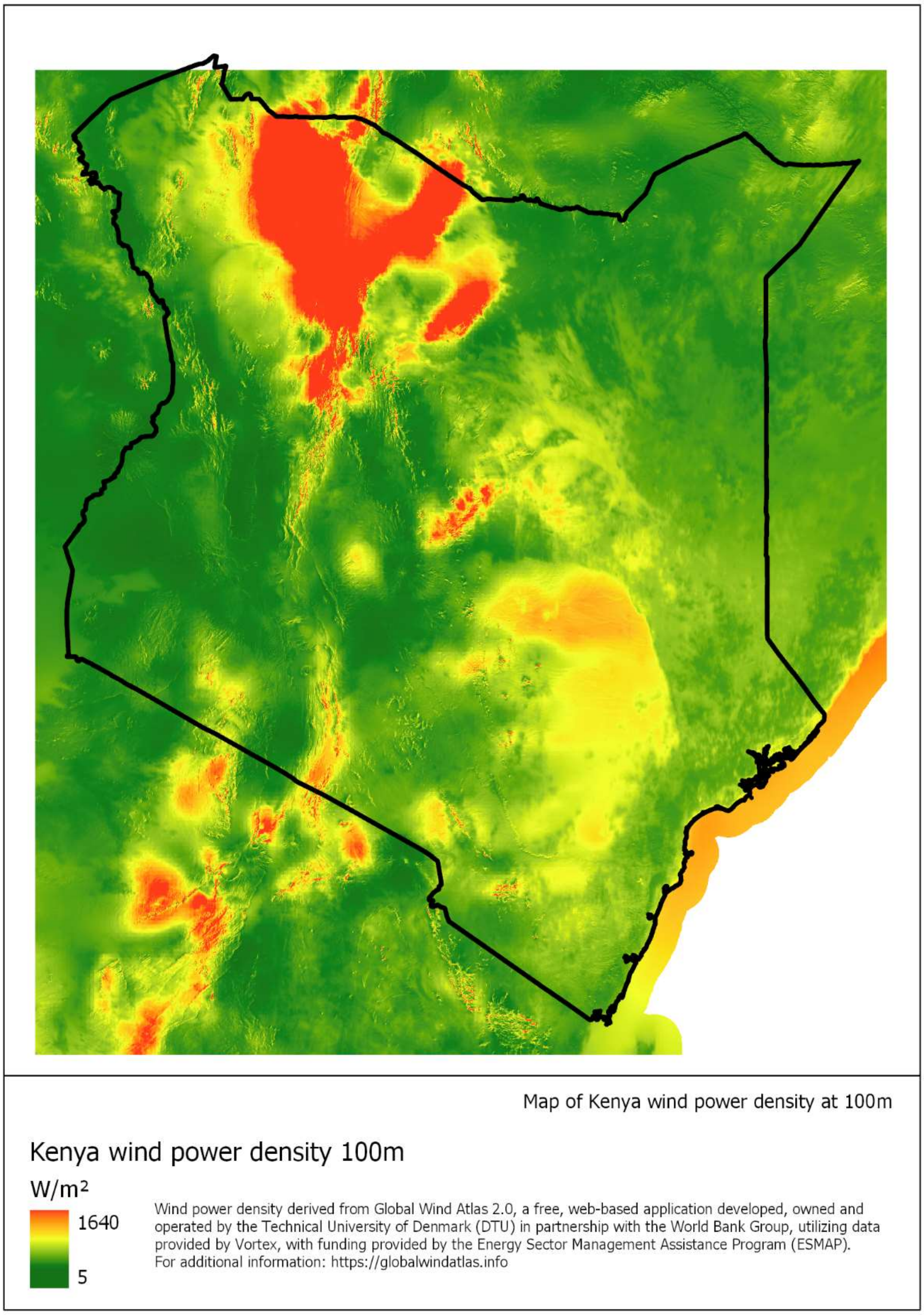

Figure 4-1. Wind power density at 100 m height, from the Global Wind Atlas 2.0 (representing the most up-to-date wind resource mapping for Kenya), with county boundaries

There is unlikely to be wind power development except where there is economically viable wind resource. However, wind resource is not the only factor that determines the siting of wind power developments. IRENA's MultiCriteria Analysis for Planning Renewable Energy uses the methods of Wu et al. (2016) to determine the economic viability of potential wind farm locations. This is a function of the wind resource and (among other factors) distance to potential and planned transmission lines.

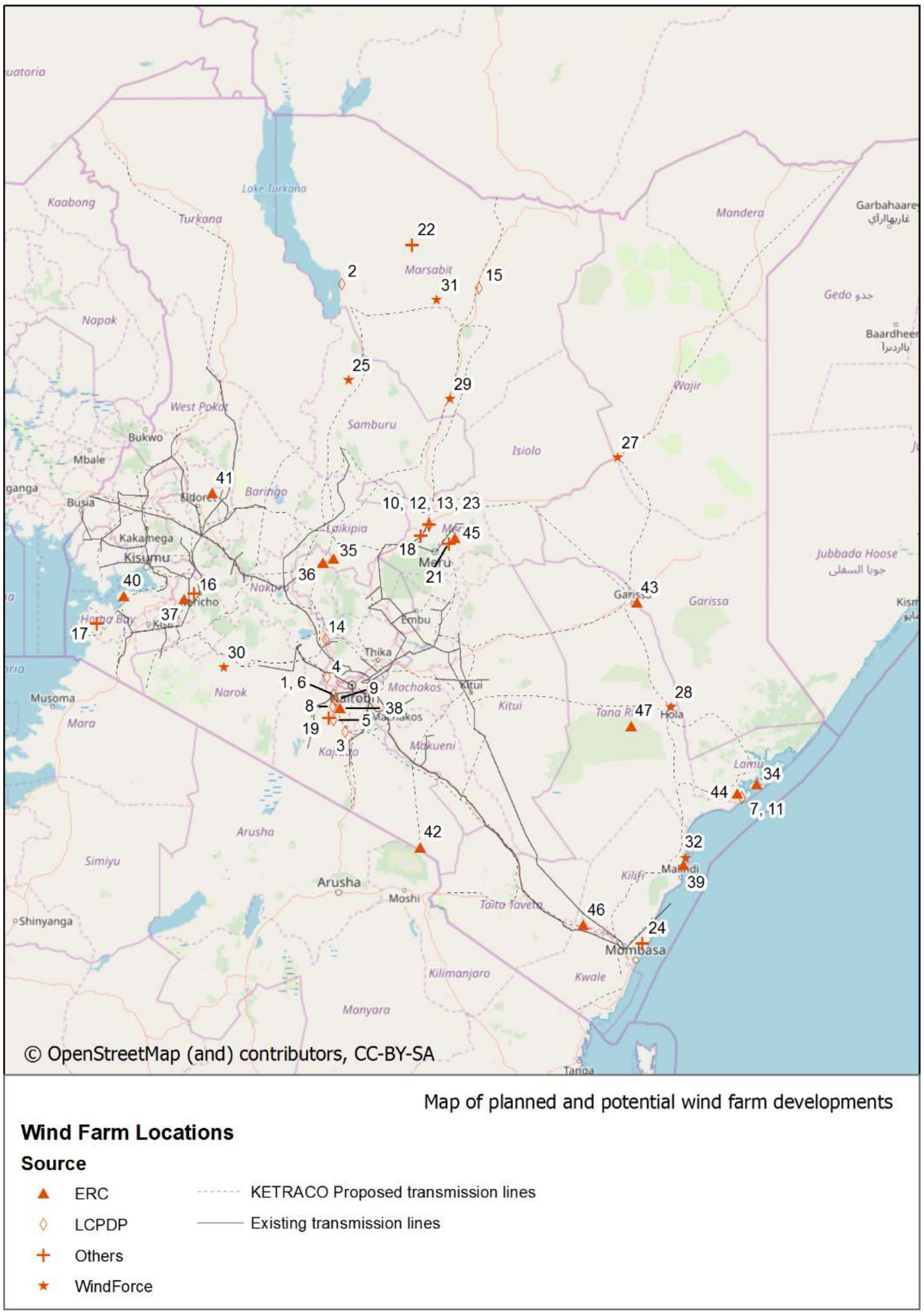

Figure 4-2. Current, planned and potential wind power projects in Kenya, with current and proposed transmission lines

For this assessment, we selected the attribute *Electricity generation discounted chosenTurbine MWhPerYr* (electgen_c). This is a measure of wind using the optimally selected IEC turbine class for that square and assuming a 75% land use discount factor[2]. We mapped this layer of economically viable wind resource on to the pentad grid used for sensitivity analysis (see section 4.2.6).

[2] Land use discount factor = A factor to discount the potential area that is likely to be developed in reality, given topographical constraints at resolutions greater than that used in the IRENA analysis, and other socio-economic or cultural considerations.

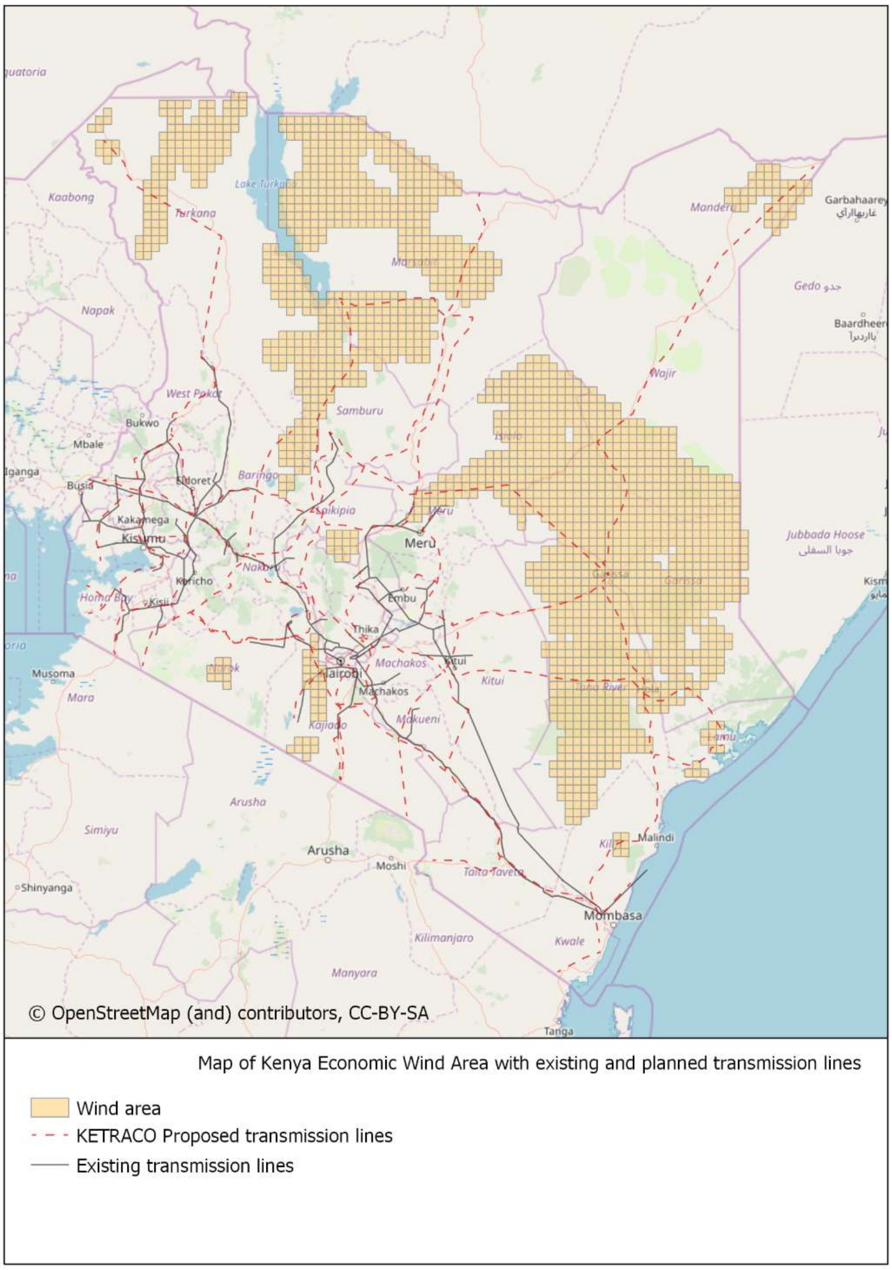

Figure 4-3. Economically-viable wind areas for Kenya (from IRENA multicriteria analysis), mapped onto the pentad grid used for sensitivity analysis (see section 4.2.6). Values in the pentads selected by the multicriteria analysis range from c. 12,500 to >300,000 MWh/Yr.

In effect, this gives a map of where in Kenya wind power development is likely to be economically viable, assuming additional transmission lines are built as planned.

Mapping these economic wind energy pentads by county provides another perspective on county-level wind resource (Figure 4-4).

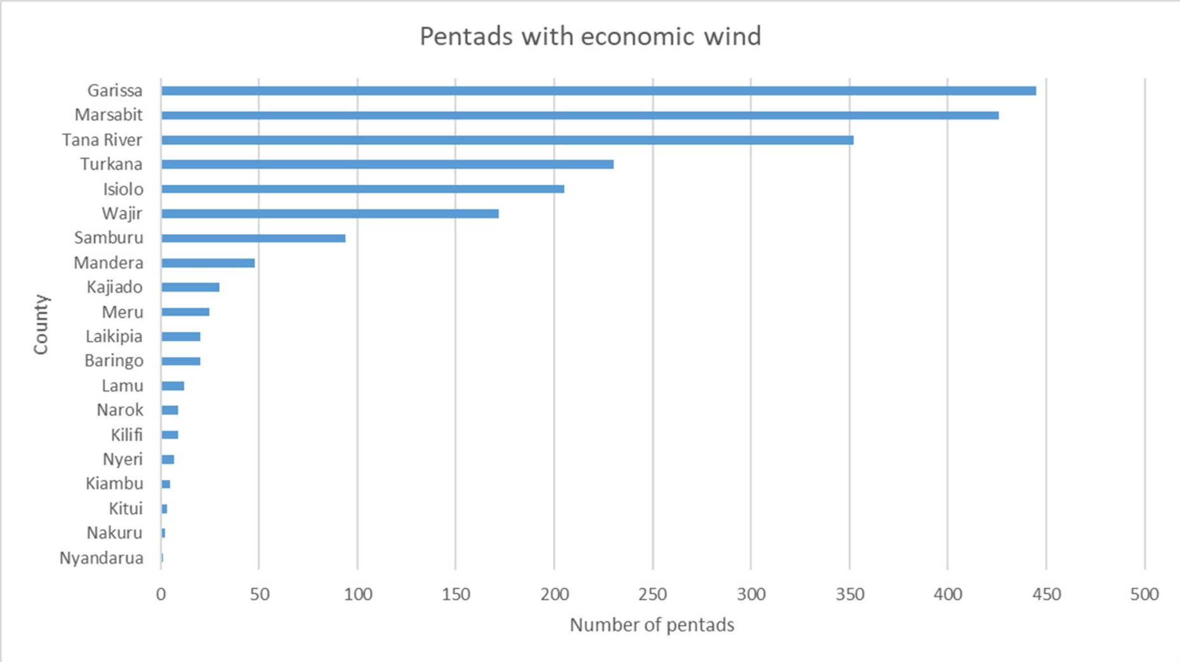

Figure 4-4. The number of pentads with economic wind resource by county, based on IRENA's multicriteria analysis

4.2.4 REVIEW OF POLICY

Environment and natural resources in Kenya are valuable national assets that must be sustainably managed for present and future generations. The promulgation of The Constitution of Kenya 2010 and other new developments like climate change marked an important chapter in Kenya's environmental policy development. The Ministry of Energy has the overall mandate in respect to policy formulation and implementation of energy efficiency and conservation. The energy sector is guided by the policy set out in Sessional Paper No. 4 of 2004 and governed by several statutes, principally the Energy Act, No. 12 of 2006, the Geothermal Resources Act No. 12, of 1982 and the Petroleum (Exploration and Production) Act, Cap 308. The Energy Act 2006 provides for the establishment of the Energy Regulatory Commission (ERC) and the Rural Electrification Authority (REA). The Act also split Kenya Power Lighting Company (KPLC) into two entities, one for transmission which is 100% state-owned and the other for distribution which will be private-sector owned. This has seen the establishment of KETRACO as a transmission company, with KPLC carrying out distribution.

The Environmental Management and Co-ordination Act (Cap. 387) (EMCA, 2018) is the umbrella legal framework in respect to environmental management in Kenya. Its implementing agency is the National Environmental Management Authority (NEMA). Although environmental management in Kenya cuts across various government agencies at both national and county levels, NEMA is charged with overall coordination and establishment of appropriate legal and institutional frameworks for management and conservation of biological diversity. Key policy and legal documents that were considered in the policy review for this SEA are illustrated in Figure 4-5 below.

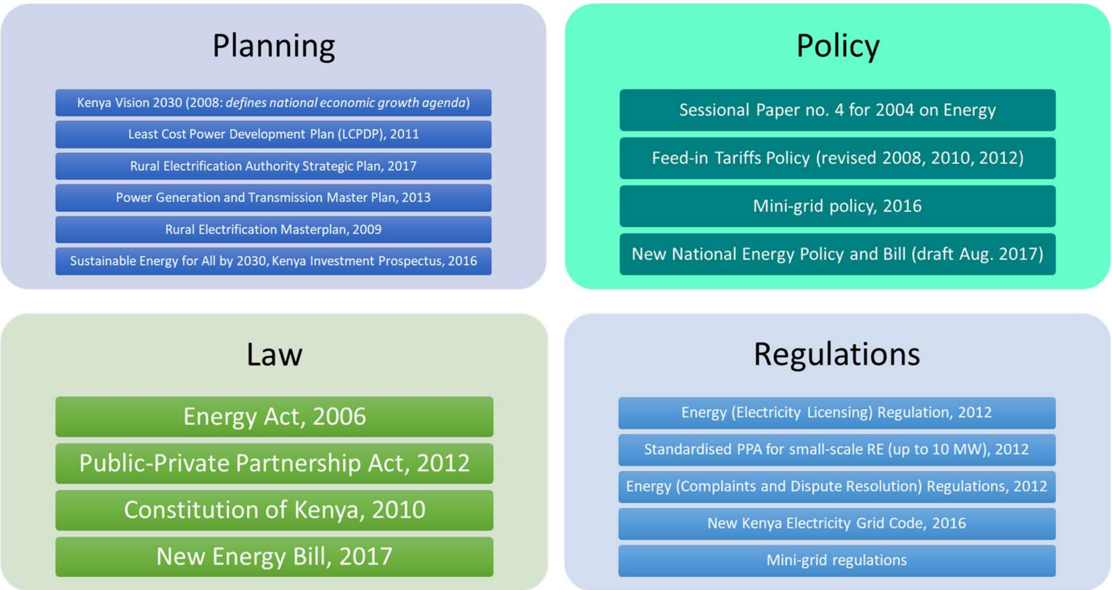

Figure 4-5. Key elements of the governing framework for the energy sector in Kenya (ad from GIZ 2016)

The Government of Kenya recognises the key role of renewable energy sources in enhancing the country's electricity supply capacity and diversification of generation sources. To this end, the MoE continues to improve the policy and regulatory framework for renewables, including wind, in Kenya. Section IV of the Energy Bill 2017 is on Renewable Energy, with a whole clause (90) on Promotion of Renewable Energy. A further clause (106) is on the Renewable Energy Feed-in Tariff System (initiated in 2008 and amended in 2012), primarily aimed at incentivizing and catalysing the generation of electricity through renewable energy sources by providing investment security and market stability for private investors.

However, the feed-in tariff model, now operational for about ten years in Kenya, has been criticised for raising electricity costs. The Government of Kenya has initiated discussions to abolish the current feed-in tariff system and replace it with an energy auction tariff that will see the government award energy contracts to companies offering the lowest electricity tariffs. Energy auctions are also expected to spur significant growth in the renewable energy sector, making energy cheaper, more readily available and more reliable for individual consumers and businesses.

Overall, the governing framework for the energy sector in Kenya contains a diverse array of laws, policies and regulations. The Kenyan Government has shown support for renewable energy projects through formulation of policies and strategies to encourage uptake of renewable energy as an option in the country's energy mix. Analysis of the major policy instruments point towards government commitment and efforts to promote renewables at different scales: off-grid, mini-grids and on-grid. However, these efforts also need to be supported by relevant and adequate capacity at individual and institutional level for renewable energy development.

4.2.5 VEC IDENTIFICATION

Wind power development may have a range of biodiversity impacts. These typically can include:

- *Habitat loss or degradation*: Compared to other renewable energy sources, such as hydro and solar, the direct footprint of wind power projects is relatively small. Natural habitat may be cleared to construct turbine bases and access roads, including for transmission lines. Roads may also be upgraded to allow transportation of large and heavy turbine parts. New or upgraded roads on or off site may pose barriers to some animal species, creating fragmentation of habitats, and creating induced human access that can increase pressures on natural resources. Some birds may also avoid foraging or nesting close to wind turbines or transmission lines, this displacement resulting in effective loss or degradation of habitat for those species.

- *Mortality from collisions or other interactions with wind turbines*: To people, wind turbines may look conspicuous and easy to avoid. However, they pose a significant risk to some bird and bat species. Turbine blades appear to move slowly, but the blade tips have high angular velocity. Many birds and bats have been killed by collisions with turbine blades (and sometimes towers) at wind farms around the world. Collision rates vary greatly among species, and are influenced by size, manoeuvrability and behaviour. Bat species might also be killed by pressure changes (barotrauma) close to moving turbine blades, though current scientific opinion regards this as unlikely.
- *Mortality from collisions with transmission lines*: Electrical connections within a windfarm are usually buried underground, but above-ground transmission lines typically take the generated electricity to the national grid. Bird deaths by electrocution can occur on transmission lines, but this is unusual, in contrast to the electrocution incidents that commonly occur on poorly-designed distribution lines. A more significant threat is collisions, where birds fly into the near-invisible wires, most often the thin earth wire that usually runs some distance above the conducting wires.

The assessment aimed to identify the most significant biodiversity risks through identification and prioritisation of 'Valued Environmental Components' or VECs. According to the IFC, VECs are defined as '*sensitive or valued receptors whose desired future condition determines the assessment end points to be used in the cumulative impact assessment process*'. VECs were identified and prioritised through a stakeholder-led process involving a biodiversity expert workshop held on 13 March 2018 in Nairobi. The workshop brought together 23 bird and bat experts, along with representatives from Power Africa and Kenya Government. Identified VECs included:

1. Site VECs holding sensitive biodiversity that could be impacted through collisions with turbines or transmission lines, or from a wind farm's footprint. Eight potential types of site VECs were identified: Bat roosts, bird nest and roost colonies, key biodiversity areas (KBAs) including important bird and biodiversity areas (IBAs), migratory routes, protected areas (including conservancies), slopes and ridgelines, and wetlands
2. Bird and bat species VECs at high risk of collision with turbine blades or transmission lines. A total of 144 VEC species were identified and prioritised in the Very High, High and Moderate vulnerability categories based on collision risk and conservation/demographic status. Over half of these were raptors, reflecting the high collision risk and often high threat status among this group. Species categorized as low risk were not considered further in the assessment.

Lastly, the expert group recognized that there are substantial gaps in the data available on the status, distribution and movements of species VECs in Kenya. These gaps were assessed and prioritized, after which targeted field surveys were planned and conducted to address these priorities, for both bats (survey in coastal counties) and birds (satellite tagging of vultures and a survey, both in far northern Kenya).

4.2.6 DATA COMPILATION

We compiled spatial data on species and site VECs from a wide range of sources, including national and international databases, citizen science projects, satellite-tagged birds, 'grey' and published literature and expert knowledge, supplemented by data from field surveys.

Data were compiled in a Geographic Information System (GIS), managed by BirdLife International. Data layers were mapped to the pentad grid used by the Kenya Bird Map project, enabling future compatibility with this important national citizen science project and combining data at a scale relevant for wind power projects.

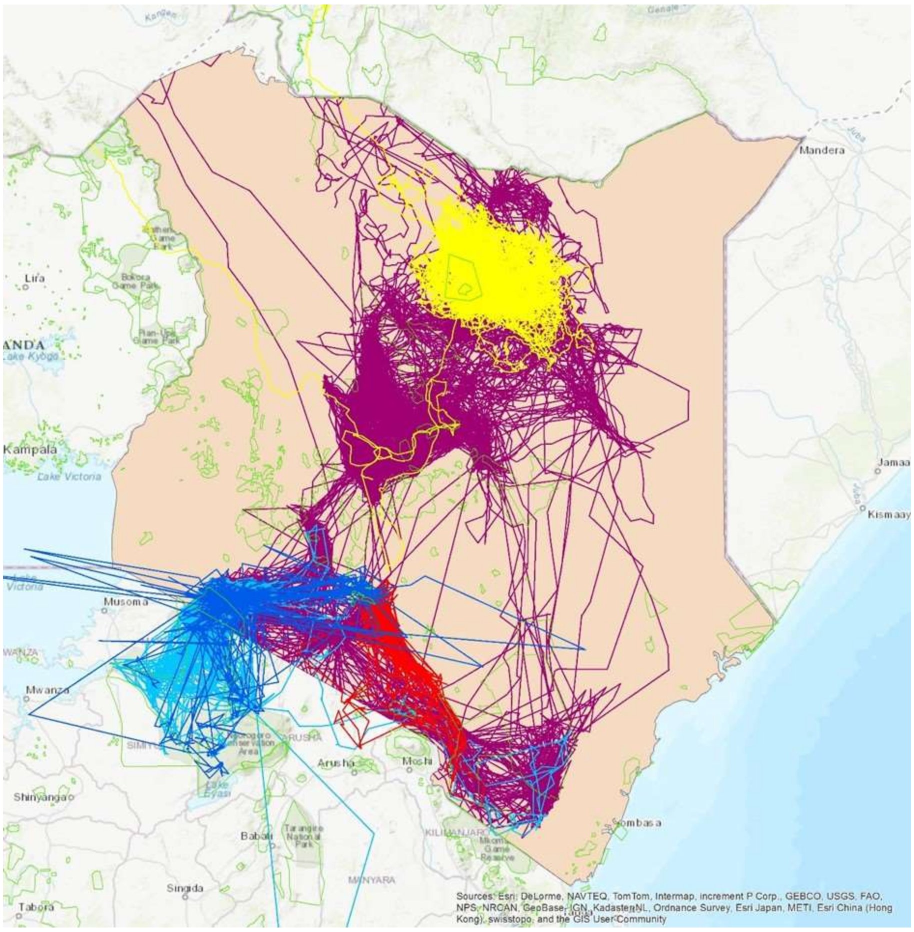

Figure 4-6. Tracks showing movements of 76 satellite-tagged vultures across Kenya (colours correspond to different tagging projects; data from this assessment, The Peregrine Fund, North Carolina Zoo and University of Utah)

4.2.7 SENSITIVITY ANALYSIS

For species VECs, we combined three key data layers, using appropriate weightings:

- BirdLife's 'Area of Habitat' range maps for birds, created from ecological models that assess where species are likely to occur within their general mapped range. These were weighted in accordance with the species' sensitivity category
- Location records for bird and bat species, using observations and specimens from many sources
- Analysis of time spent per pentad for 76 satellite-tagged vultures, from data generously made available by vulture researchers at The Peregrine Fund, North Carolina Zoo and University of Utah, as well as birds tagged for this assessment. Vultures are the species group of highest concern for wind power impacts, being highly threatened and highly prone to collisions.

For site VECs, we combined information on protected areas, key biodiversity areas (Important Bird and Biodiversity Areas, IBAs), wetlands and slopes. Where available, the information for site VECs included maximum counts of triggering species VECs at those sites, important to ensure compatibility with the BirdLife Sensitivity Mapping Tool for wind power. IBAs were weighted where relevant by the sensitivity categories of VEC species that triggered IBA identification.

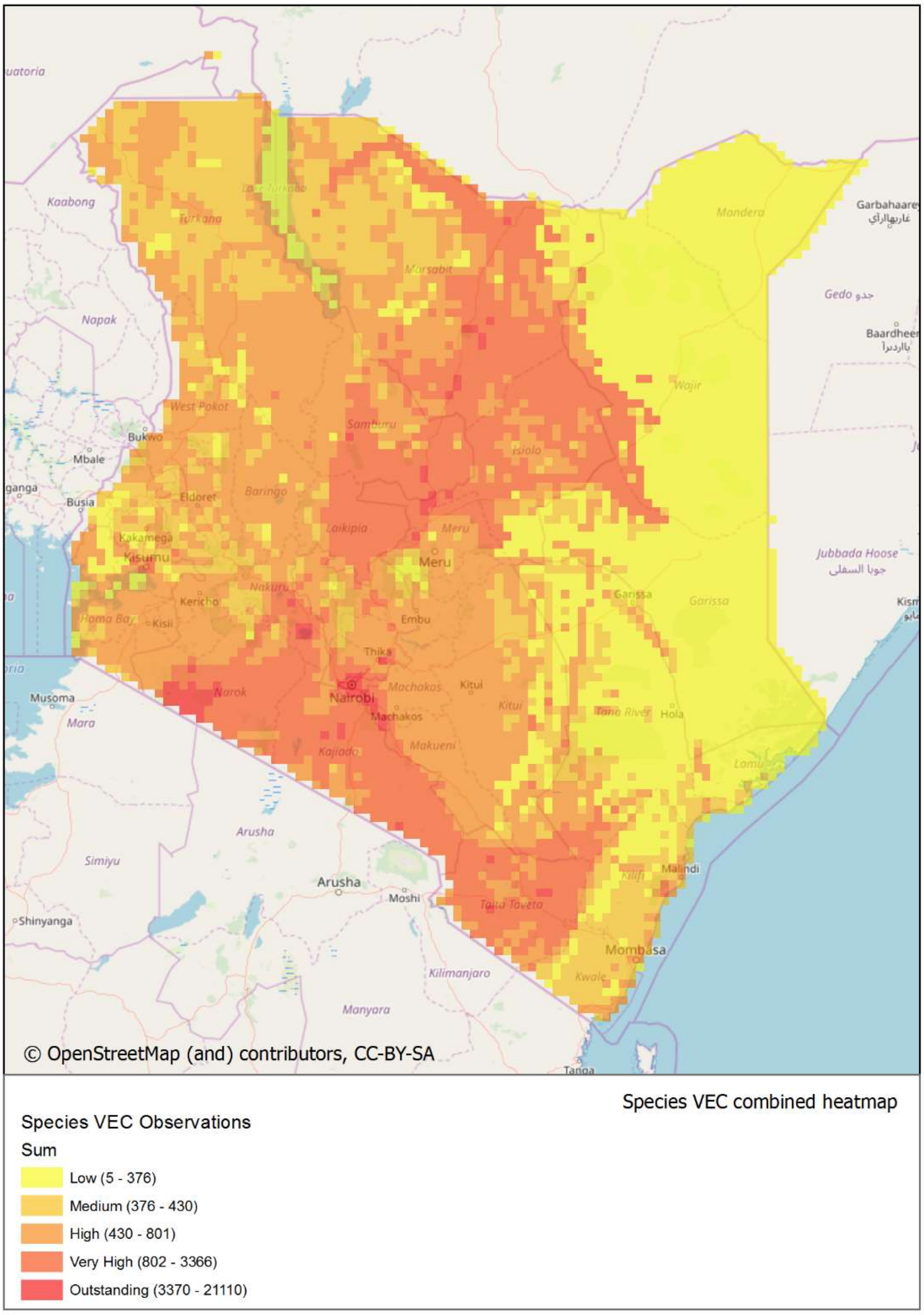

Figure 4-7. Combined VEC species heatmap, produced by adding scores for area of habitat weighted species richness, weighted observations, and vulture movements

Combined sensitivity maps: As a final step, we overlaid the synthesis heatmaps of risk for species and site VECs with the locations of planned and potential wind energy developments, and with economic wind areas in Kenya, to identify areas and locations at risk.

4.3 KEY FINDINGS OF SENSITIVITY ANALYSIS

4.3.1 SPECIES SENSITIVITY

The overall 'heat map' for species sensitivity is shown in Figure 4-8Figure 9-30. Broadly speaking, areas of elevated sensitivity (Very High or Outstanding) are concentrated in a band running north-east to south-west across the central part of the country, from Moyale to the Masai Mara, and along the southernmost part of the country from Narok to Taita Taveta counties. Pentads with Outstanding sensitivity are concentrated in the Masai Mara area, east and south of Nairobi, in Tsavo and around Nakuru, Isiolo and Marsabit.

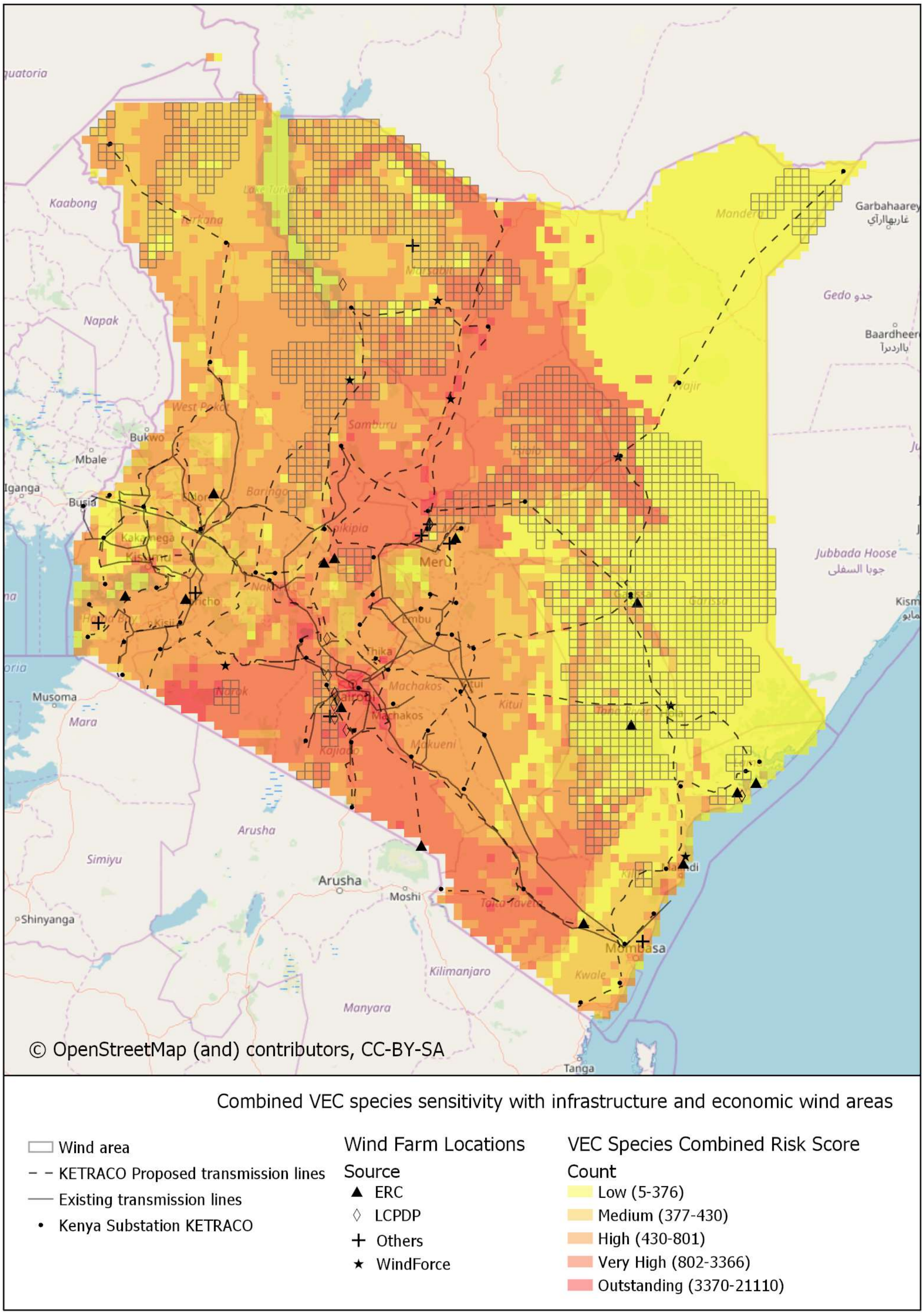

Figure 4-8. Synthesis VEC species heatmap overlaid with economic wind area and planned/potential developments.

4.3.2 SITE SENSITIVITY

Pentads with Very High or Outstanding site sensitivity are scattered across Kenya, largely reflecting the location of Important Bird and Biodiversity Areas, particularly wetlands sites identified as important for specific VECs. Vulture colonies are distributed in a broad band running south-west to north-east from the Masai Mara to Moyale, as well as in Tsavo, closely congruent to the band of elevated sensitivity for species VECs (see section 4.3.1). Bat colonies are scattered but mainly concentrated at the Kenya coast, far western Kenya, and in the central Rift Valley and highlands.

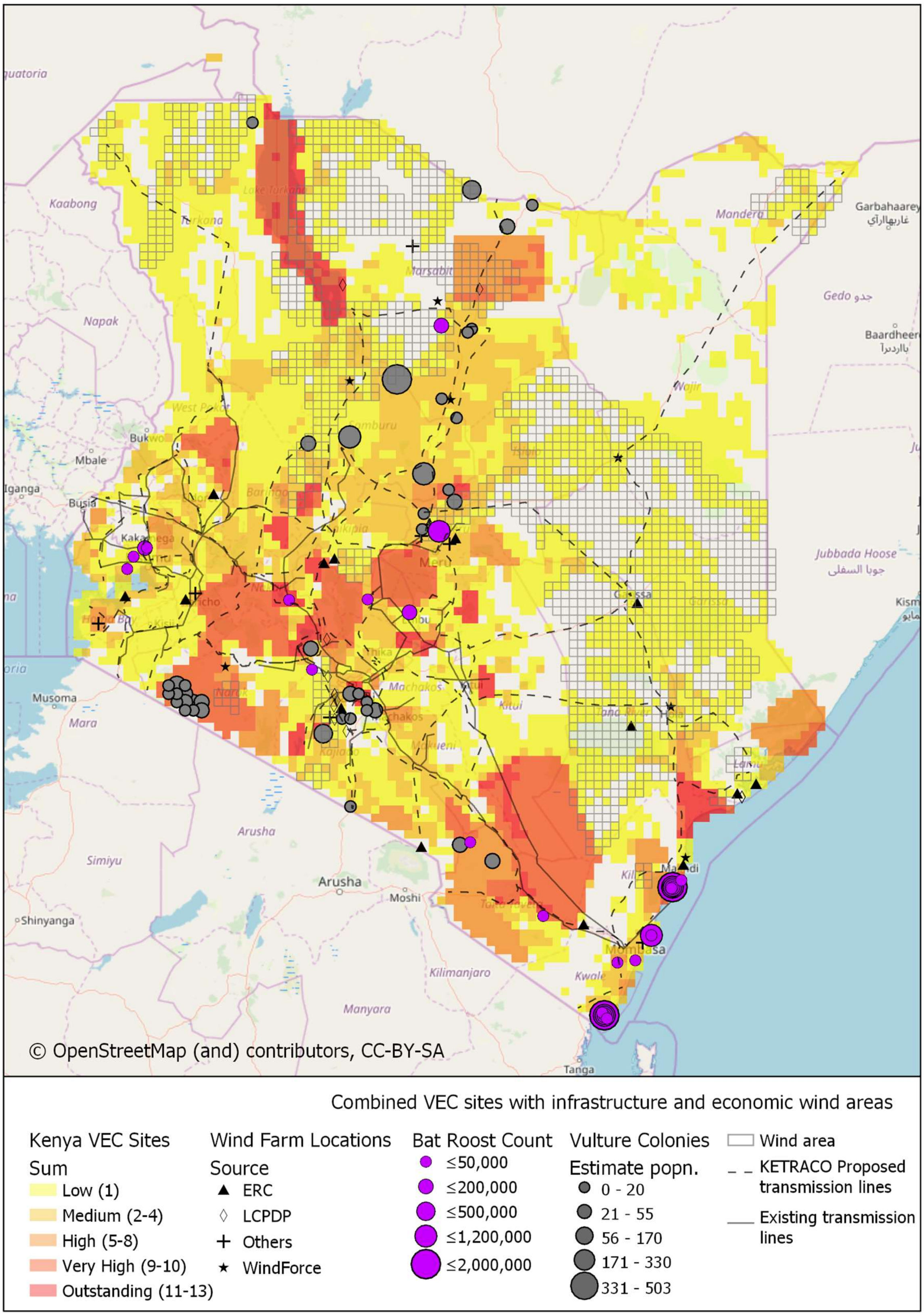

Figure 4-9. Synthesis VEC sites heatmap overlaid with economic wind area and planned/potential developments, as well as locations of major bat and vulture colonies

4.3.3 SENSITIVITY IN ECONOMIC WIND AREAS

Overall, most of the economic wind area is not a high risk for biodiversity (Figure 4-11 and Figure 4-12), suggesting that avoidance of risk is a broadly feasible option, given sufficient advanced planning.

Figure 4-10Figure 9-28 summarizes this information. The pie charts of pentad area in each sensitivity category show that species sensitivity is, overall, much greater than site sensitivity in economic wind areas; and that around 17% of pentads are 'very high' sensitivity for species. A small proportion of pentads (only 0.1%, 171 pentads) are 'outstanding risk' for species, though 2% are in the highest category (2,903 pentads) for sites.

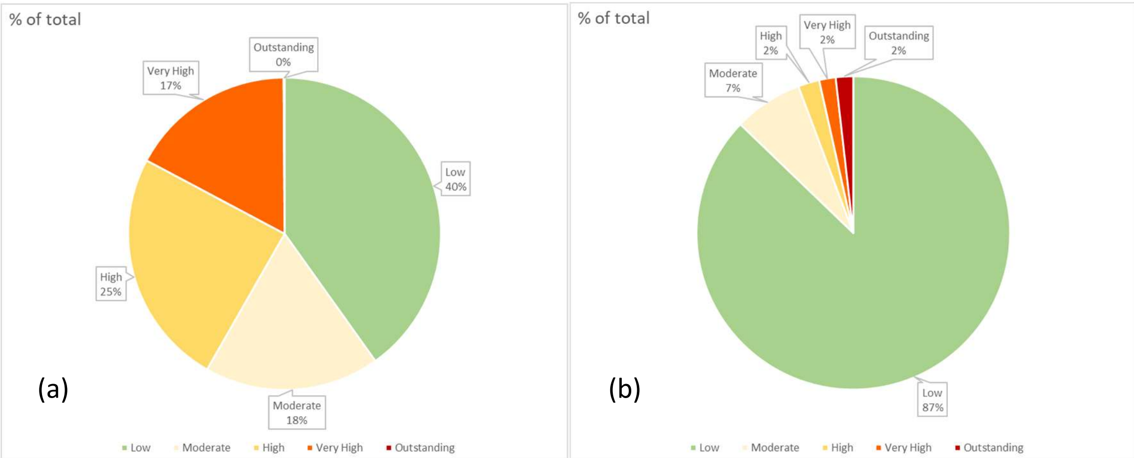

Figure 4-10. **(a) Proportional distribution of combined VEC species sensitivity categories across the economic wind area in Kenya. Of 16,3233 km^2 of economic wind area in total, 27,935 km^2 is 'Very High' and 171 km^2 'Outstanding'. (b) Proportional distribution of combined VEC site sensitivity categories across pentads in the economic wind area in Kenya. Of 16,3233 km^2 in total, 2,733 km^2 is 'Very High' and 2,903 km^2 'Outstanding'.**

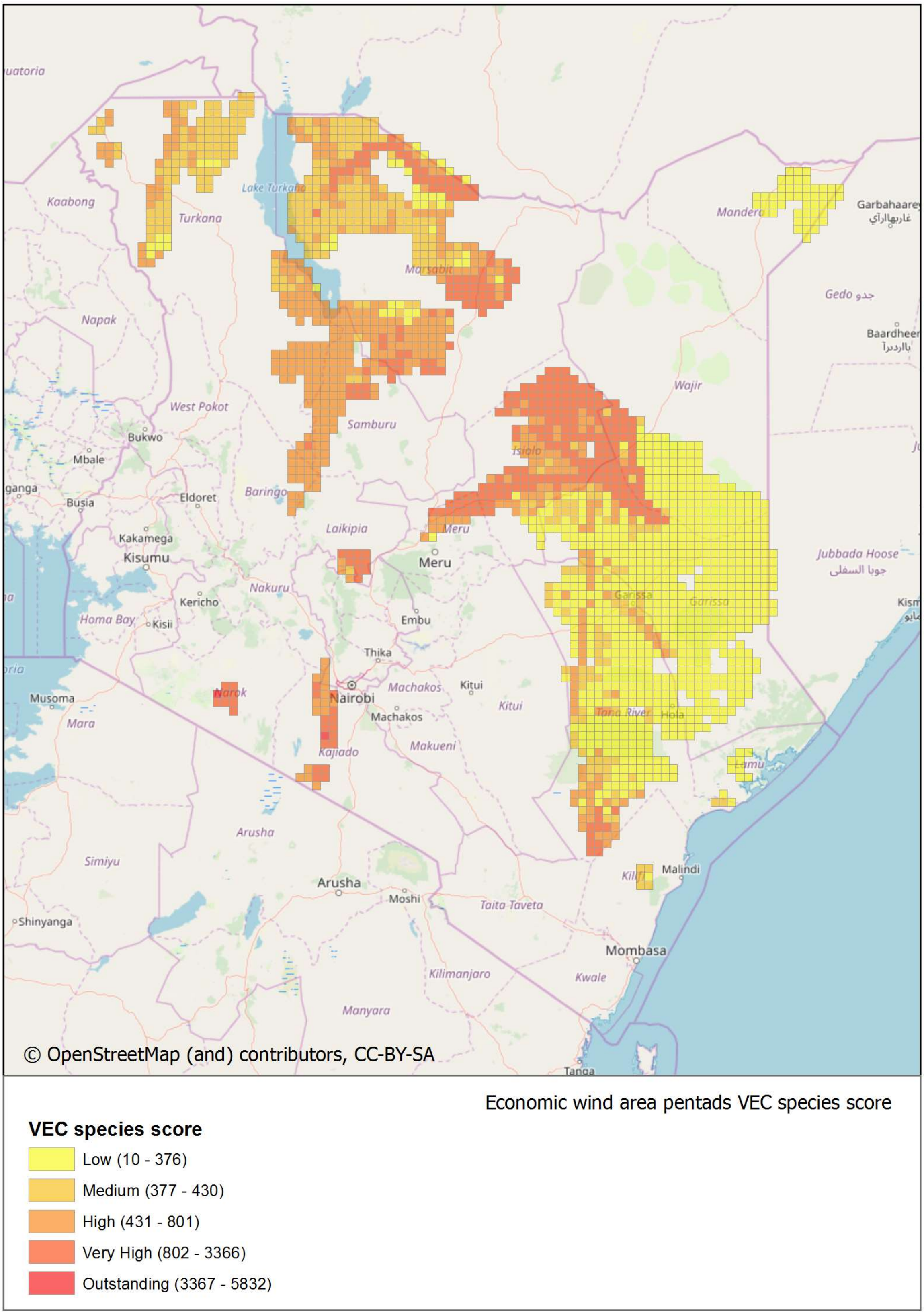

Figure 4-11. Sensitivity categories for pentads within economic wind areas in Kenya, based on the synthesis VEC species risk heatmap.

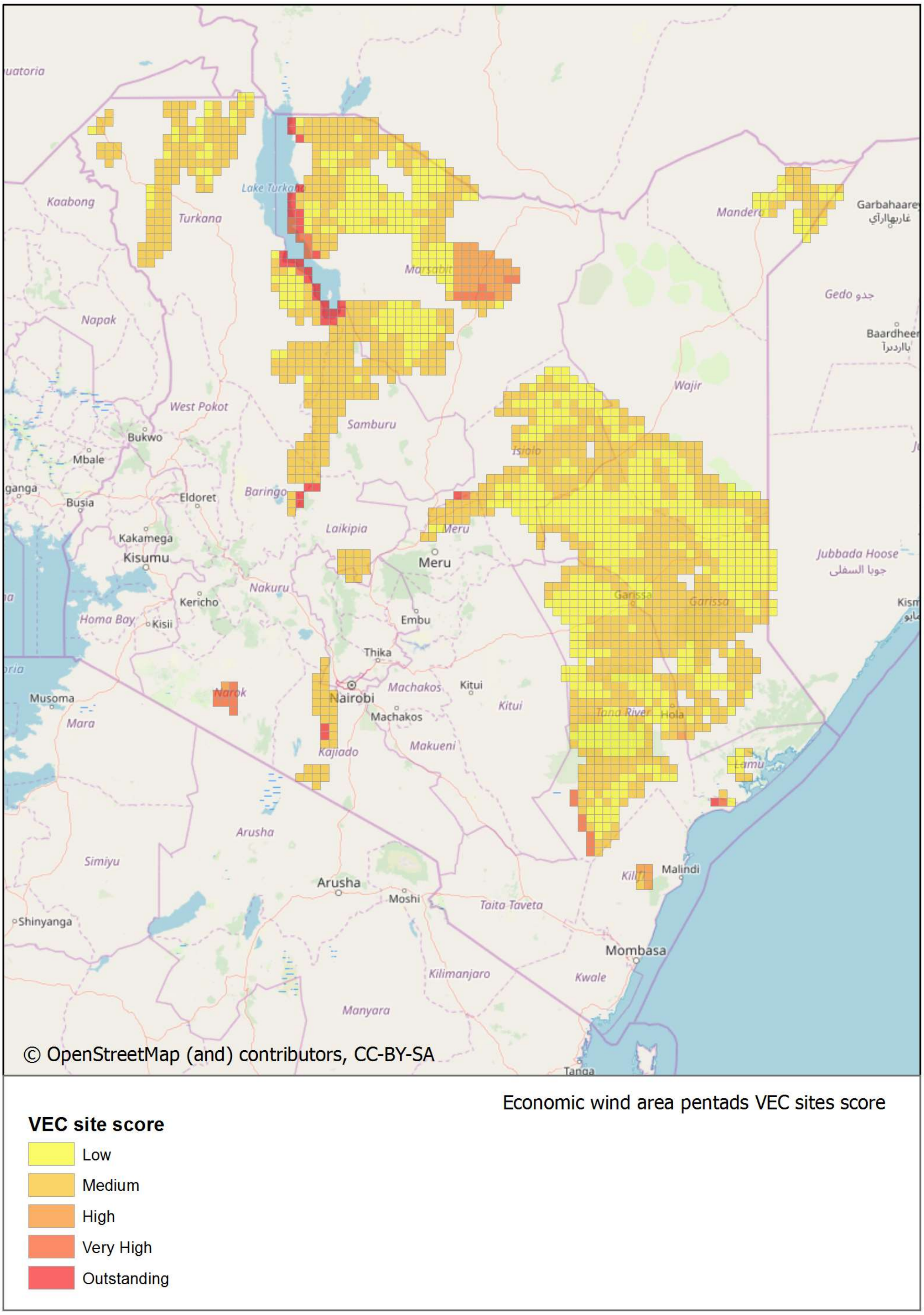

Figure 4-12. Sensitivity categories for pentads within economic wind areas in Kenya, based on the synthesis VEC sites risk heatmap.

4.3.4 COUNTY-LEVEL ASSESSMENT

Different counties vary not only in their wind resource but in the biodiversity sensitivity of areas that have wind potential. Figure 4-13 shows for each county the number of pentads with economic wind area (counties with none are not included), and the number of these pentads that are of very elevated risk – i.e. classed as Very High or Outstanding Sensitivity, for species, for sites, and for both. For most counties elevated species and site sensitivity overlap, but not completely.

Several things are evident from the chart:

- Generally, biodiversity risk is driven by species sensitivity rather than site sensitivity in these counties with areas of economic wind potential.
- Several counties have a high proportion of very elevated risk in their economic wind areas – these include Narok, Laikipia, Meru, Kajiiado and Isiolo. With the exception of Narok, however, some economic wind pentads in these counties do have more manageable levels of risk (in the Low, Moderate or High sensitivity categories). In Narok, the limited wind resource is all at very elevated risk.
- Several counties have many pentads with very elevated risk, but also many where risk levels are lower (in the Low, Moderate or High sensitivity categories). These include Wajir, Marsabit and Garissa.

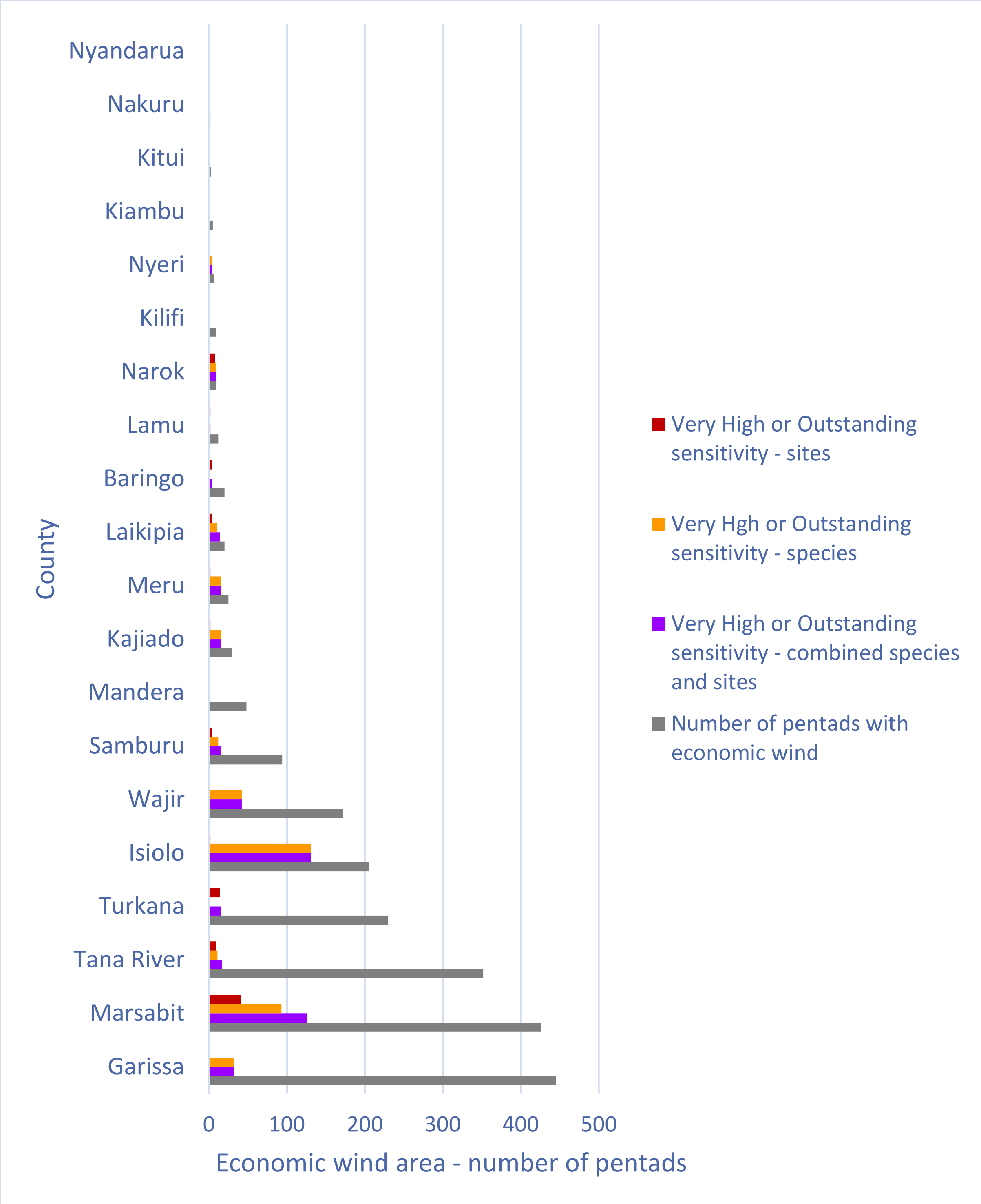

Figure 4-13. Number of pentads per county with economic wind potential that have very elevated (Very High or Outstanding) biodiversity sensitivity for species, for sites and for species and sites combined.

4.3.5 RISK TO CURRENT, PLANNED AND POTENTIAL WIND DEVELOPMENTS

Another aspect of risk is the sensitivity of pentads with current, planned and potential wind developments. Figure 4-14 shows that the sensitivity of most pentads containing wind farm sites is Low, Moderate or High, i.e. not of very elevated risk, though High risks may still require careful management. No development is in the same pentad as a bat or vulture colony.

However, there is **very elevated risk** for one development in each of Narok, Nakuru, Laikipia and Wajir, and for several developments in each of Marsabit and Kajiado. In Kajiado, there are seven projects with developments at very elevated risk, four of which have a vulture colony in at least one adjacent pentad. Meru has no developments in pentads at very elevated risk, but five developments have a vulture colony, and four of these a bat colony also, in at least one adjacent pentad (Figure 4-14 inset).

Figure 4-15 and Figure 4-16 highlight the sensitivity categories of pentads containing current, planned or potential wind energy developments, for species and site risk respectively.

Pentad sensitivity categories and related data for the developments listed in Table 7-4 are shown in A.2.

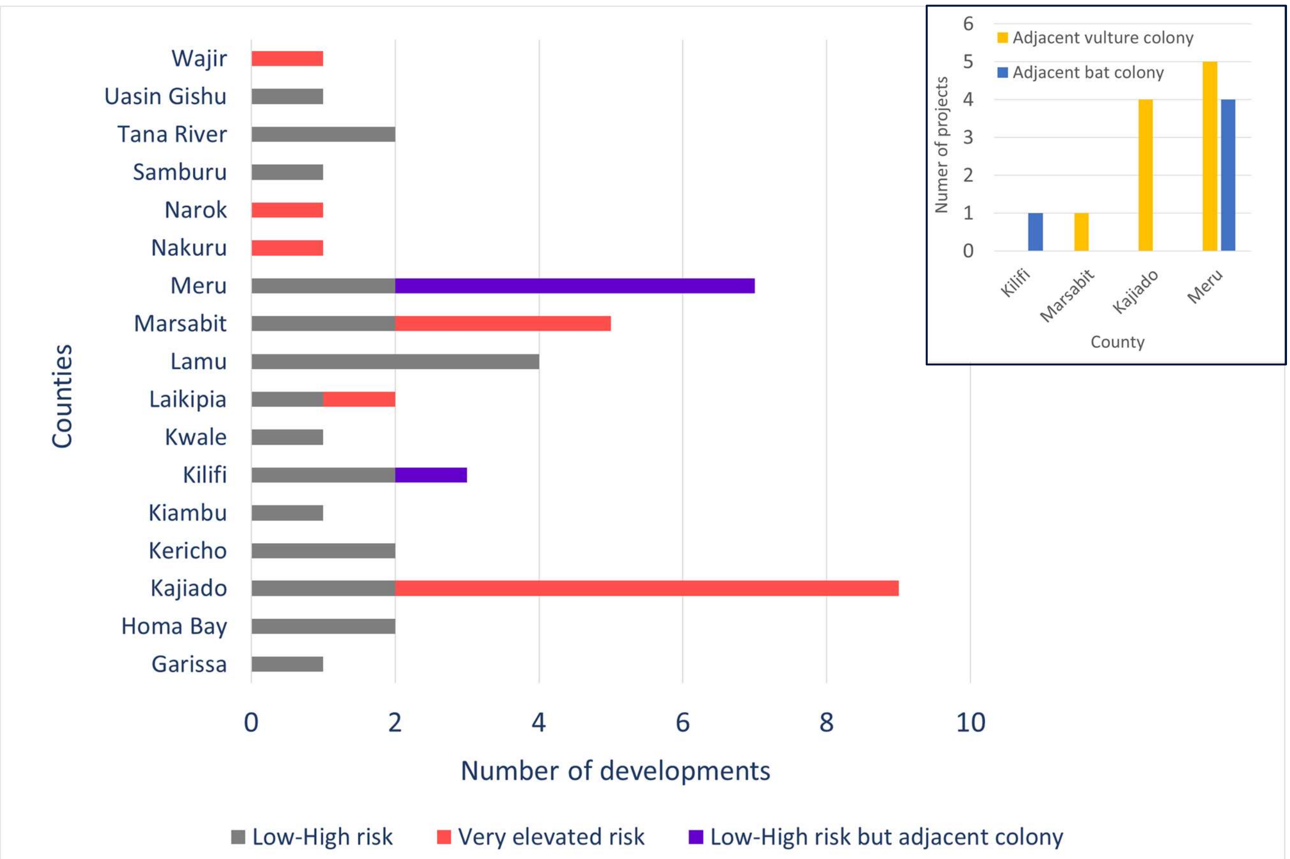

Figure 4-14. Summary of pentad sensitivity (sites and species combined) for current, planned and potential wind power developments in Kenya. 'Adjacent colonies' means that the pentad is not itself of very elevated risk (i.e. it is categorised as Low, Moderate or High risk, but not Very High or Outstanding), but it is adjacent to a pentad containing a mapped bat roost or vulture colony. Inset chart shows the number of pentads with wind developments adjacent to a pentad with a vulture or bat colony.

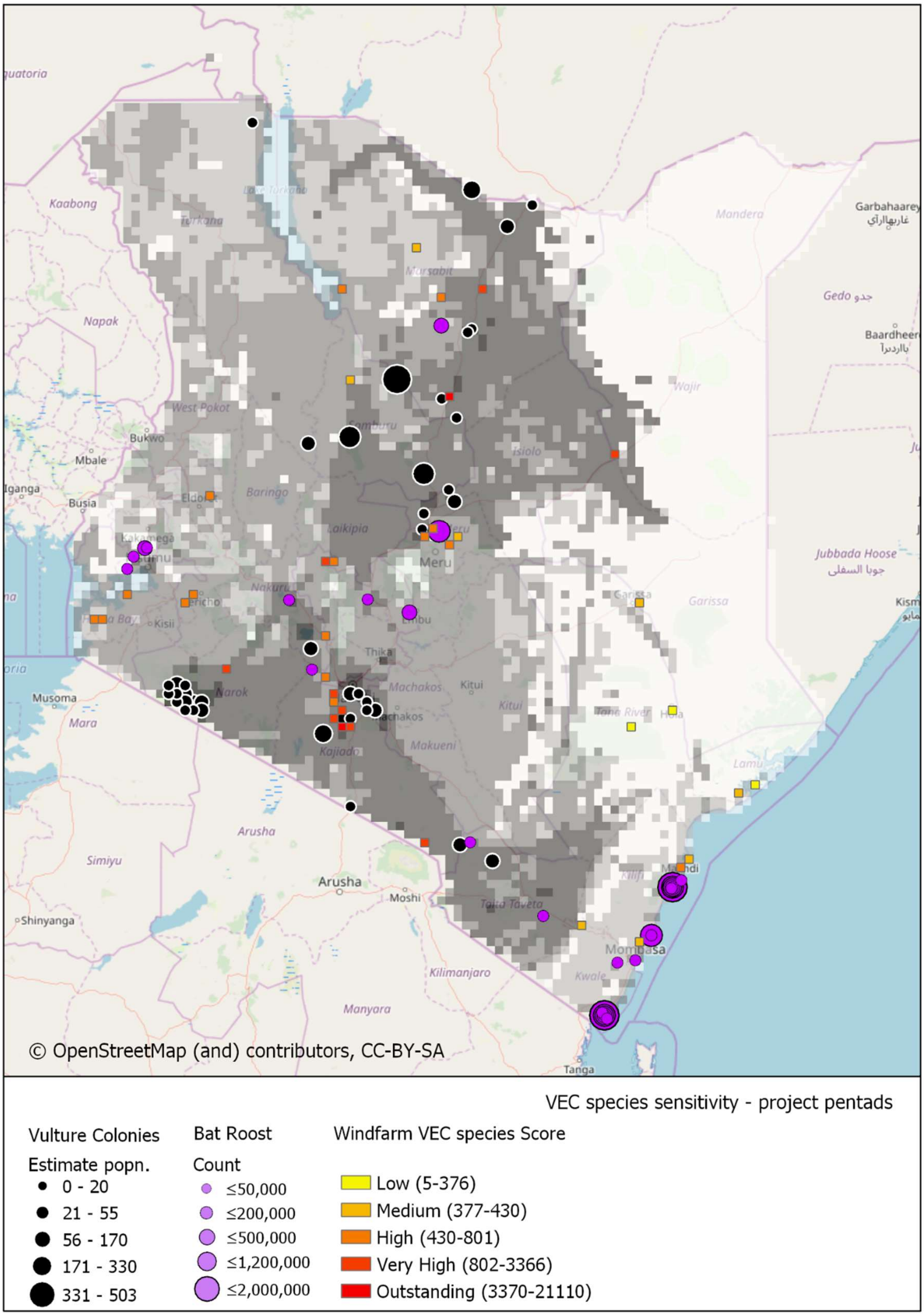

Figure 4-15. Species sensitivity categories for pentads (in colour) where there are planned or potential wind energy development in Kenya. Categories are based on the synthesis VEC species risk heatmap. Locations of major bat and vulture colonies are also shown.

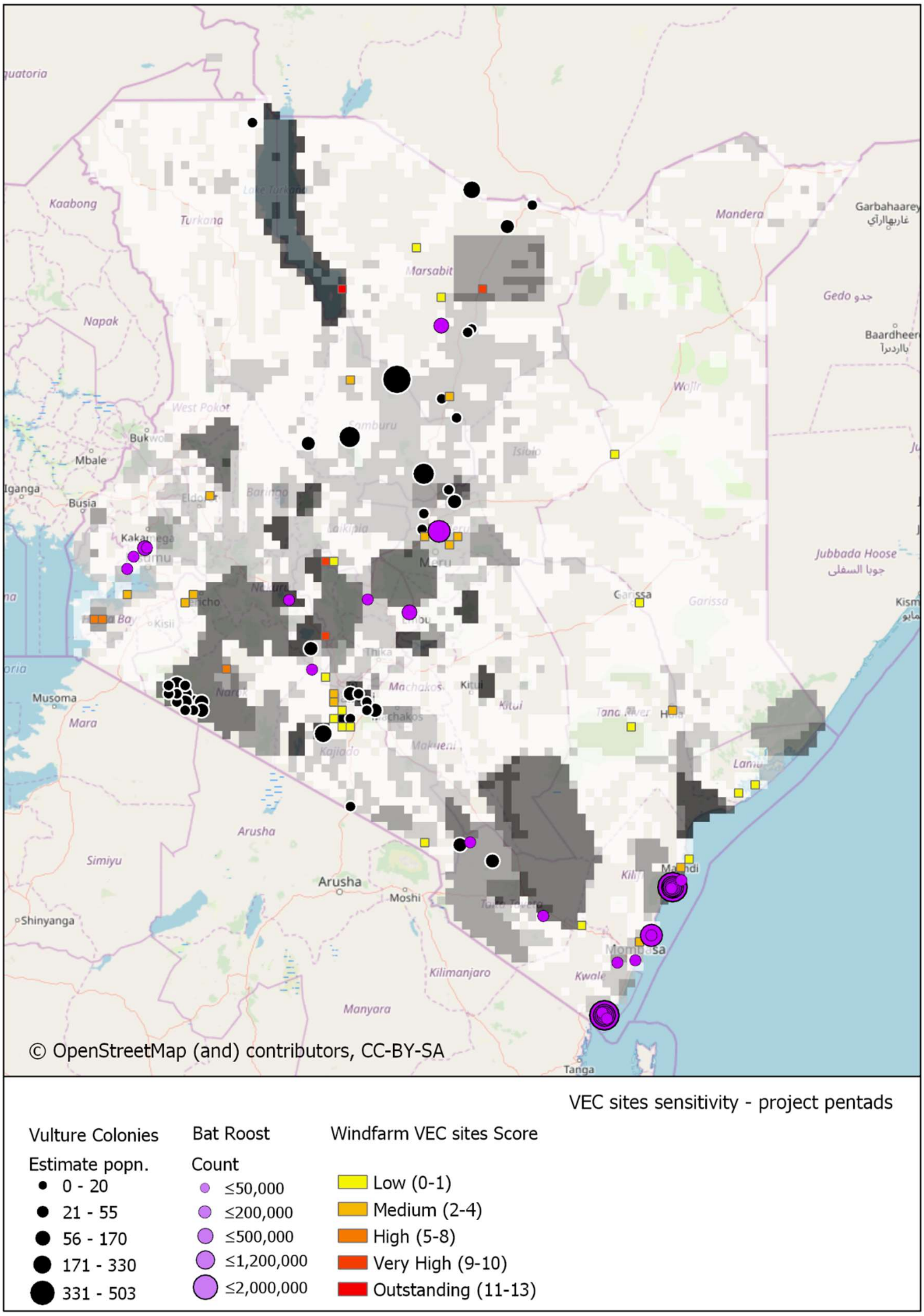

Figure 4-16. Site sensitivity categories for pentads (in colour) where there are planned or potential wind energy development in Kenya. Categories are based on the synthesis VEC species risk heatmap. Locations of major bat and vulture colonies are also shown.

4.3.6 CUMULATIVE IMPACTS

With a large number of current, planned and potential on-grid wind farms in Kenya, some of them in very sensitive locations, the issue of cumulative impacts requires attention. Cumulative impacts are an important concern for any sector, but particularly for wind, because impacts need to be considered at a broad scale. Many species at risk of collision move over large distances, in the course of which individuals could encounter many wind farms, putting them at risk multiple times. The more wind farms and transmission lines in its foraging range or migration route, the higher the risk of collision for an individual bird or bat.

A meaningful assessment of cumulative impact for VEC bird and bat species is very difficult with the data presently available. At this point, it is possible only to examine in a general way which species may be most at risk at population level from potential cumulative impacts. This is a first step in addressing the question as to whether cumulative bird and bat deaths from wind turbines are significant at population level, and/or in relation to all other anthropogenically-caused bird deaths for priority VECs.

One way to achieve some insight is through a first-cut analysis of Potential Biological Removal (PBR). This is a measure of the number of individuals that can be removed from a population annually by human-induced mortality (e.g. through hunting, or collisions with infrastructure) without causing noticeable population-level effects. PBR can be viewed as a measure of the 'spare' capacity created by a population's intrinsic ability to increase. PBR is one way to estimate a limit of acceptable change for VECs.

In reality, many of the bird VECs in this study have populations that are declining, not stable or increasing – suggesting there is no such 'spare' capacity at present. PBR is still a useful measure to calculate, as it provides an indication of the likely proportional effect on a species' population from cumulative impacts. For example, cumulative impacts will have a relatively lower population-level effect on a declining species with a large PBR compared to one with a small PBR.

PBR depends on a species' demographic characteristics and on its conservation status, which may affect its ability to bounce back from pressures. PBR was calculated for bird species VECs based on demographic and threat data supplied by BirdLife International.

Not all VEC species with low calculated PBRs are likely to collide with wind turbines or transmission lines. Some are assessed at only low or moderate overall of collision. However, a number of species with 'outstanding' PBR constraints (PBRs of 100 individuals or fewer) or 'very high' PBR constraints (>100 to 1000 individuals) are classed as high- or very-high sensitivity VECs. As PBRs apply to the species' global range, of which Kenya usually forms a small proportion, acceptable mortality from wind power impacts in Kenya may be a very few (or even zero) individuals. These species thus require particularly close attention for mitigation.

4.3.7 IMPLICATIONS FOR POLICY AND PLANS

The Energy Bill 2017 has provided direction in the Kenya energy development sector with a strong focus on promoting the development and use of renewable energy technologies. However, great flexibility remains in terms of the ways in which this is put into effect given the wide scope of potential renewable technologies. This SEA makes the assumption that the need and demand for power and production plans outlined in the policy and plan documents has considered appropriate alternatives at that level. Specifically, Kenya's energy needs cannot be met without expanding the renewable energy sector, and thus the wind power development plans cannot be reasonably avoided or substituted in totality. The question for this SEA is thus where those developments should be situated. Sensitivity mapping has identified parts of the country where wind power development is viable and potential adverse impacts on biodiversity can be minimised. It has also identified a number of planned and potential projects situated in sensitive areas (Annex A.2), and parts of the country with good wind potential but elevated risk of negative biodiversity impacts (Figure 4-13). Risks are overall much greater to species VECs (mainly from collisions, for these mobile species) than to site VECs (mainly from project footprint).

Wind developers take into consideration several factors when they decide where or whether to pursue development of a wind power project. These factors include the wind resource, accessibility and connection requirements, environmental risks and potential community impacts. In general, the places most suitable to place wind projects have strong and consistent winds; large, open spaces; reasonable access; minimal risk to wildlife; and supportive local communities.

This assessment provides the biodiversity element of that analysis, which can be used in a future step to inform a comprehensive evaluation and prioritisation of candidate areas for site selection of sustainable wind farms at a national level, adequate to support strategic spatial planning by policy-makers.

The current assessment already allows identification of four key scenarios based on information on wind and on biodiversity sensitivity (Figure 4-17).

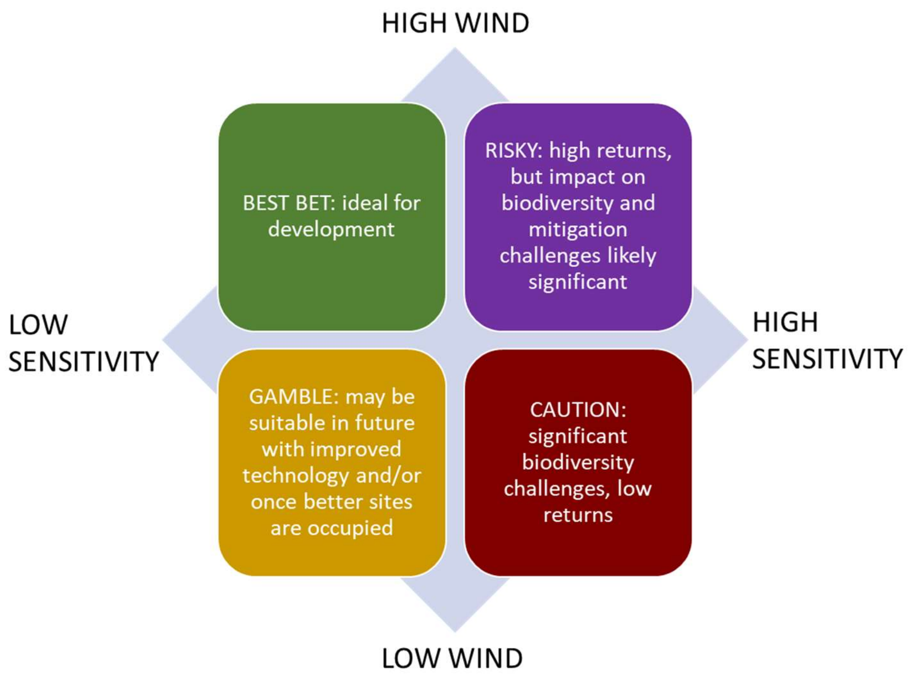

Figure 4-17: Four broad scenarios for wind power development decisions based on the wind resource level and the level of biodiversity sensitivity. The 'best bet' and 'risky' scenarios correspond broadly to the economic wind pentads categorised respectively as 'low' or 'moderate', and as 'high', 'very high' or 'outstanding', in Figure 9-30 and Figure 9-28

4.4 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

4.4.1 OVERVIEW

The Environmental Management and Monitoring Plan (EMMP) outlines the actions needed to reduce, manage and monitor adverse biodiversity impacts in the wind energy sector, as identified in the sensitivity analysis. An EMMP is a living plan to be used adaptively, and updated and amended as new information, technologies, policies and legal frameworks (including international agreements) become available.

This plan focuses on implementation of the mitigation hierarchy, a practical and widely-applied framework to help limit the negative environmental impacts of development projects. The mitigation hierarchy is the sequence of actions to anticipate and *avoid* impacts on biodiversity; and where avoidance is not possible, *minimize*; and where impacts occur, rehabilitate or *restore*; and where significant residual impacts remain, *offset* (CSBI 2015).

In this SEA, the emphasis is *avoidance* through site location, but outline guidance is also provided on mitigation measures that should be considered during the construction, operational and de-commissioning stages of wind power projects, addressing the other three components of the mitigation hierarchy. Much detailed guidance on many of these measures is available elsewhere.

4.4.2 MITIGATION HIERARCHY

Kenya's regulatory framework and good international industry practice both require that developers follow the mitigation hierarchy. Avoidance and minimisation are particularly key stages in the mitigation hierarchy, as these serve to prevent impacts before they happen, rather than attempting to remediate them afterwards. For wind power projects, there is usually little scope for restoration of impacts, while offsets can be challenging, uncertain and costly. An emphasis on prevention is thus crucial.

4.4.3 AVOID (DESIGN, PLANNING, PRE-CONSTRUCTION)

Location of wind farms and transmission lines is the single most important factor in determining biodiversity impacts. Some locations are much more sensitive than others – e.g. migration bottlenecks, ridges used by soaring birds, and areas of high biodiversity value such as Key Biodiversity Areas. Avoidance is the theme of the sensitivity mapping undertaken and reported in this SEA.

4.4.3.1 RISK SCREENING

Early screening can improve macro-level project site selection and the scoping of priorities for further assessment thus reducing unnecessary biodiversity impacts and project costs in the future[3]. It is an essential part of due diligence in project development.

Desk-top screening for wind power projects presents challenges. Useful information on highly mobile species, such as vultures and large eagles, may not be available at the right spatial scale. The information in this SEA is useful for initial screening, but Investment and design decisions should not be made on the basis of sensitivity maps alone, but need more detailed information and ground-truthing from other sources.

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[3] See https://www.thebiodiversityconsultancy.com/wp-content/uploads/2017/01/Biodiversity-Screening-IBN_20170123-FINAL-1.pdf

4.4.3.2 STRATEGIC PLANNING

Environmental and social risks to projects can be greatly reduced, along with uncertainty and cost to developers, through integrated strategic land-use planning. Such plans consider potentially conflicting uses and requirements across different economic sectors, as well as social and environmental factors. Typically, they will make a strategic consideration of trade-offs and identify zones for different land-uses. A broad array of relevant methodologies is available for the wind sector. This SEA can serve as an input into a broader plan that considers in more detail a range of technical, economic and social as well as environmental factors.

4.4.3.3 APPROACHES TO AVOIDANCE

Project screening, use of sensitivity mapping, and strategic land-use planning all support *avoidance by site selection* – they help to ensure that projects are placed, all else being equal, in less sensitive locations with relatively low potential biodiversity impacts.

Avoidance needs to consider not just the site itself (to avoid footprint impacts) but the role of sites in supporting or attracting sensitive species. Avoidance of sensitive sites applies equally to transmission lines as to wind turbines.

There is usually limited scope in wind power developments for *avoidance by project design*. Within site, power lines are usually buried which avoids electrocution or collision impacts. Adjustments to turbine or transmission line height, and burying problematic stretches of transmission line, may avoid impacts to some species in some circumstances.

Avoidance by scheduling is often considered during construction. Some wind farms have also scheduled curtailment during well-defined migratory seasons when sensitive species are passing through, or to avoid impacts on species that are active only during certain times of the day or night. Such measures can be effective, but at an economic cost.

4.4.4 MINIMISE (POST-CONSTRUCTION, OPERATIONAL)

Minimisation actions are to a degree site- and project-specific, but a range of measures can be successfully deployed.

4.4.4.1 MINIMISING ATTRACTION OF SENSITIVE SPECIES

Keeping sites and surroundings clean of livestock or wildlife carcases, and carefully managing waste, is essential to avoid attracting vultures or other scavenging birds. This is likely to involve a permanent team of staff, and to require close engagement with local communities.

4.4.4.2 FEEDING STATIONS TO DIVERT VULTURES

Where vultures or other scavenging birds forage frequently over a wind farm site, vulture feeding stations (or ‘restaurants’) could have potential to attract the birds to spend time elsewhere. Whether feeding stations attract vultures depends on a number of circumstances and effectiveness cannot be guaranteed. Feeding stations need careful siting and management to avoid a number of potential drawbacks, and can be expensive to maintain. It may be valuable to trial them in Kenya as a mitigation measure.

4.4.4.3 SHUTDOWN ON DEMAND

This involves strategic, short-term shutdown of turbines to minimise potential impacts. It can be an effective means of mitigation for particular high-priority species at risk. In summary, observers at fixed vantage points scan for priority bird species approaching the wind farm. If an individual bird is on a flight path that is likely to result in collision with a turbine, observers notify the wind farm control centre (e.g. by mobile phone or radio), and the 'risk turbine' (or turbines) is immediately shut down, to be re-started when the risk of collision has passed.

Radar is also used for shutdown on demand, either alone or, increasingly, to support observers. Radar can significantly improve the detection of birds at risk in some situations. However, it has the practical drawback that (as yet) it is not possible to identify the bird species from the radar system.

A number of automatic image detection systems are now also in development. Camera-based systems are still evolving and likely to become more effective, and less costly, over time.

Shutdown on demand reduces overall power generation, but usually by a very small amount if well managed.

Shutdown on demand, whether observer or machine led, is likely to be costly – vigilance across the whole site perimeter is required whenever the target species are active and turbine blades are turning. In Kenya, cost and the availability of observers are likely to favour an observer-led approach at present. This can also help fulfil a project's social responsibilities to create employment and develop skilled capacity.

4.4.4.4 MICRO-SITING OF TURBINES AND SELECTIVE CURTAILMENT

Baseline surveys, and the EIA process, should identify sensitive areas within the proposed wind farm perimeter. Siting turbines away from these areas can minimise potential impacts. This is particularly useful for bats, which often forage in focused areas and particular habitat types.

Monitoring at established wind farms shows that in most cases a few 'killer turbines' account for nearly all the fatalities. Behavioural study of target species and topographic mapping can help determine potential problem locations, but these can be difficult to predict accurately in advance. If specific problem turbines are identified post-construction, an effective mitigation approach may be to curtail operations for those specific turbines when sensitive species are flying.

4.4.4.5 TURBINE SELECTION

In many but not all cases, potential biodiversity impacts could be reduced by installing fewer large turbines, rather than many small ones, which also would reduce vegetation clearance needed for installation.

4.4.4.6 TURBINE LAYOUT

Good practice advice is to avoid closely packed turbines, where a bird or bat avoiding one may immediately encounter another, and to maintain corridors in between turbine lines that are aligned with main flight directions. Thus, lines of turbines should run parallel to features such as valleys, rivers, or any known flight path, and not across them.

4.4.4.7 PAINTED TURBINE BLADES

Attempts to improve birds' avoidance of collisions by making turbines more conspicuous through alarms, lights or bright colours have so far had little success. An approach that may be effective is painting one of the three turbine blades. Research into birds' visual systems (which are very different to humans') shows that this may help them detect the blades better. Blade painting has been tested at one wind farm in Norway where it has greatly reduced collision rates.

4.4.4.8 TRANSMISSION LINES

Transmission lines pose a significant collision risk to some bird species. Collisions are mainly with the earth (shield) wire, which is usually thin and raised above the conductors – so is hard for birds to see.

Collision risk can be reduced by careful routing, so that transmission lines are not placed across flight routes or near wetlands or other features associated with high avian traffic.

Line marking to increase visibility is a standard 'good practice' mitigation measure that should be applied routinely to transmission lines. It usually provides substantial but not complete mitigation

Many different line-marking devices are available, including aviation balls, spirals and flappers. Many modern designs are 'glow in the dark', so are visible at night. For most circumstances in Kenya, alternating spirals and flappers will be suitable, placed every 5 m or so along the central two-thirds of the span between support poles.

4.4.4.9 BAT-SPECIFIC MITIGATION MEASURES

Wind-turbine cut-in speed is the lowest wind speed at which turbines generate power to the utility system. Bats are more active at low wind speeds. Studies show that slightly raising the turbine cut-in speed can significantly reduce bat mortality with only a marginal loss of power output.

Acoustic deterrents broadcast noise similar to bats' ultrasonic calls that they use to echolocate and find food. This technology is still in development, as the disruptive signal attenuates rapidly and at present is only effective very close to the turbines. It is not useful for the larger fruit-eating bats ('flying foxes') that do not echolocate.

4.4.5 RESTORE (OPERATIONAL, DE-COMMISSIONING)

4.4.5.1 RESTORATION OF FOOTPRINT IMPACTS

While restoration is an important component of the mitigation hierarchy, for wind power its role in reducing residual impacts is usually relatively small. This is because 'footprint' impacts, which restoration addresses, tend to be less significant than collision impacts. Nevertheless, limited restoration of habitat impacts will be possible for most sites, during operation or following decommissioning.

4.4.5.2 REHABILITATION OF INJURED BIRDS

One specific application of restoration is to rehabilitate (and where feasible release) birds, particular raptors, that have been injured by wind turbines or transmission lines. Although many collisions result in fatalities, sometimes disabling injury (e.g. a broken wing) is the result. With specialist attention, such birds can be saved and – if rehabilitation is fully successful – eventually returned to the wild. Where injuries cause permanent damage that prevent a bird being released, rescued birds at specialist centres can be used in education and awareness programmes for conservation, or potentially for captive breeding. Though rehabilitation is a specialised and generally costly exercise, it is well worthwhile for long-lived and threatened birds of prey, such as vultures and large eagles, where every individual is of high value for conservation.

It is recommended that wind farms with potential impacts on raptors or other large birds engage with and support established rehabilitation organisations, i.e. the Kenya Bird of Prey Trust and the Raptor Rehabilitation Trust Kenya, as an element of their restoration efforts. This engagement could be bilateral or (perhaps more valuably) co-ordinated through an industry environmental forum.

4.4.6 OFFSET (PRE-OPERATIONAL, OPERATIONAL, DE-COMMISSIONING)

Biodiversity offsets are conservation actions designed to compensate for unavoidable impacts on biodiversity. Offsets address significant residual impacts after avoidance, minimisation and restoration measures have been applied as fully as possible. Offsets can take the form of **restoring** degraded ecosystems or species populations, or protecting biodiversity from existing threats, thereby **averting loss**.

Kenya does not at present have a regulatory requirement to offset project impacts for the energy sector, though this policy landscape may change over time. However, good international industry practice (GIIP[4]) requires that developers follow the mitigation hierarchy, where offsets are the final step to address residual negative impacts. The safeguard frameworks of most lenders also require offsets in many circumstances. For example, IFC's widely-applied Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources requires projects to achieve no net loss where feasible for natural habitats, and net gain for critical habitats[5]. Where there are unavoidable residual project impacts, achieving no net loss or net gain will require offsets.

4.4.6.1 OFFSET PRINCIPLES

The Business and Biodiversity Offsets Programme (BBOP) has established a set of offset principles[6] (with broad stakeholder agreement) that are regarded as a benchmark of good international practice.

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[4] According to the World Bank Group, GIIP is defined as the exercise of professional skill, diligence, prudence, and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity, as well as varying levels of financial and technical feasibility

[5] "Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes" (IFC 2012). IFC's Guidance Note for PS6, revised in 2019, sets out criteria, thresholds and the assessment approach for identifying critical habitats.

[6] The BBOP standard on biodiversity offsets can be found here: https://www.forest-trends.org/publications/standard-on-biodiversity-offsets/

4.4.6.2 PLANNING FOR NET GAIN / NO NET LOSS

Projects that may have impacts on sensitive species (or ecosystems), and that intend to align with international good practice, should start planning early for how to achieve net gain or no net loss. It is not practical to demonstrate net gain or no net loss for 'biodiversity' as a whole. Rather, the specific features that will be the focus of offset compensation need to be identified.

Good information is key for planning and achieving net gain or no net loss. Usually, initial risk assessment surveys should be followed by more intensive surveys focused on priority species – to determine their presence and activity across the course of a year at least. These data can then support the assessment of potential impacts (before mitigation) and residual impacts (after mitigation is applied).

4.4.6.3 OFFSET OPTIONS

Assessment of residual impacts and offset planning should be carried out prior to construction and operations. Preferably, offset actions should be in place before the project begins to operate, to avoid time lags between losses and gains.

The scale of offset required will need to take into account uncertainties in loss/gain estimates. A precautionary approach is required – i.e. assuming that neither mitigation nor offset actions will work perfectly as planned, and that uncertainties may not play out in the project's favour. Estimates and the scale of intervention can be refined over time as more data are collected and as the success (or otherwise) of mitigation actions and offset interventions becomes clearer.

Offsets will obviously need to be chosen according to the priority features identified and residual impacts assessed.

For vultures, the most significant threat in Kenya is incidental poisoning, where birds die after feeding at poisoned carcases intended to kill predators. This threat is driven by human-wildlife conflict in the form of livestock predation by wild carnivores.

For raptors more generally, including vultures, a range of threats includes habitat loss, persecution and – increasingly – collision and electrocution on powerlines.

4.4.6.4 OFFSETS FOR VULTURES

For vultures, a wind-farm offset is being piloted in Kenya using an *integrated anti-poisoning programme*. This will be geographically focused on identified 'hotspots' of vulture activity and poisoning risk. The programme has several mutually-reinforcing components:

- Community engagement and awareness raising, through a network of 'vulture scouts' co-ordinated by project field staff in focal areas
- Community development support, linked to anti-poisoning activities
- Livestock protection. e.g. boma reinforcement and improved herding practices, working with established predator protection programmes in southern Kenya
- Rapid detection and response to poisoning incidents, to rescue birds where possible, prevent more birds being poisoned, and collect samples and data for investigation
- Support to Kenya Wildlife Service to respond to poisoning incidents

- Vulture tagging and nest monitoring, to understand birds' movements and behaviour, measure mortality rates, and track population health

4.4.6.5 OFFSETS FOR OTHER RAPTORS

For other raptors, several offset approaches may be viable, including:

- Conservancy conservation. Supporting the management of conservancies with important raptor populations but limited resources for implementing management plans.

- Retrofitting power lines. Retrofitting poorly-designed distribution lines that are an electrocution threat to raptors, and adding bird diverters to transmission lines that pose a collision threat.

- Rehabilitation and subsequent release of birds injured (away from the project) by e.g. poisoning, electrocution or collision

- Captive breeding and release of highly threatened or fast-declining species.

None of these approaches has yet been well-researched, or piloted, in Kenya, so further work would be required to determine viability and costs, as well as quantification of gains.

4.4.6.6 AGGREGATED OFFSET

In an aggregated offset, one offset project meets the compensation needs of two or more development projects. Gains achieved by the offset are allocated between developments according to an agreed formula, usually in proportion to the amount invested.

The costs and challenges of offset design, setup, implementation and monitoring can be considerable. By investing together in one large project, rather than several small ones, there can be considerable savings and efficiencies for each development.

The species of concern are likely to be similar for many wind farms in Kenya. Offset interventions may also often be at the landscape scale, as with an integrated anti-poisoning programme for vultures. This sets the stage for a potential aggregated approach that could provide better outcomes for developers and for sensitive biodiversity alike.

4.5 SURVEY AND MONITORING

4.5.1 PRE-CONSTRUCTION MONITORING AND ASSESSMENT

Risk assessment surveys should take place as early as possible, ideally in tandem with wind assessments, and should consider the particularities of sites, species, and seasonality. Desktop screening and short reconnaissance visits will help focus the survey effort on species or groups of likely concern, both for footprint and collision risks. It is important that sampling design and survey techniques are guided by technical experts.

The results of risk assessment surveys inform the scope and design of baseline assessment surveys. The focus of these should narrow down to the species or ecosystems identified as potentially high concern, to maximise the value of survey efforts. Survey effort needs to be commensurate with risk..

In many cases, further vantage point surveys ('skyscanning') for priority bird species will also be required. The main aim of these is to determine activity levels (passage rates) that can feed into collision risk modelling to estimate potential impacts.

Satellite-tagging of birds (or bats) should be considered where relevant, as it has particular potential to provide more, and more exact, data on behaviour of priority species, including movements and core foraging ranges.

Where multiple wind farm facilities are located in the same geographical area and near areas of high biodiversity value, wind project developers are encouraged to implement a coordinated approach to surveys and monitoring. In addition to cost effectiveness (e.g., when surveys are jointly planned and executed with shared costs), a common survey methodology and approach lend themselves to cumulative impact assessment.

4.5.2 OPERATION PHASE (POST-CONSTRUCTION) MONITORING

Post-construction biodiversity monitoring during the operational phase on-site aims to confirm or adjust bird or bat impacts predicted in the baseline studies, assess how effectively mitigation measures are being implemented, and to uncover any new or unexpected mortality or other impacts. All this helps to guide adaptive management of the facility.

Where an offset is in place, monitoring will also be needed of implementation progress and of outcomes, relevant to the metrics being used to assess gains and losses.

4.6 ROLES, RESPONSIBILITIES AND INSTITUTIONAL CAPACITY

Planning and regulation efforts may not bear fruit if they are not supported by requisite capabilities at individual and institutional levels. Some of the key policy documents reviewed recognise that lack of skills and capabilities may be limitations to renewable energy development.

It is the responsibility of the Ministry of Energy to oversee implementation of the principles, guidance and spirit of the EMMP proposed in this plan-level SEA for the wind sector in Kenya by independent developers. The National Environmental Management Authority (NEMA) has the overarching mandate of making sure that all the actions are carried out in accordance to the appropriate laws of the land, and in partnership with the requisite stakeholders. Ultimately, the successful implementation of the actions proposed in this EMMP depends on their cascading down to specific project ESIAs.

Kenya is fortunate in having substantial technical capacity for biodiversity survey, environmental assessment and conservation implementation. The skilled consultant pool is however much less exposed to the requirements of good international practice in relation to wind power. Skills in this area are be needed if mitigation measures are to be effectively designed and implemented.

Developments that need to implement significant mitigation measures (such as shutdown on demand and carcase clearance) will need to recruit and train appropriate teams to carry out this work. There is need to train trainers for this purpose.

Offsets are most often implemented by conservation NGOs, government agencies, or both. There is still insufficient capacity in both civil society and national parastatals for design and implementation of offsets; still less so in county-level governments. Moreover, offsets are likely to involve some innovative approaches, or combinations of approaches, that may also involve a broad range of organisations and communities in different roles. It will be valuable to learn from experience and other countries that have more advanced offset systems, to ensure that lessons are passed on through formal and informal means as additional offsets are planned and implemented for wind power projects.

4.7 CONCLUSIONS

4.7.1.1 LIMITATIONS OF THIS ASSESSMENT

This SEA represents a first, and ambitious, effort to assess biodiversity sensitivity in relation to wind power potential and planned developments in Kenya. It is a major advance in our understanding of the environmental risks of wind power development in Kenya, and of the opportunities for safe development that will minimise biodiversity impacts.

The substantial datasets that underpin the results give confidence that the broad findings are robust. Yet they should still be interpreted with caution, especially when assessing risk for individual wind farm locations. Ground-truthing through additional surveys and information collection will be essential before decisions are made on specific development projects.

A number of information gaps remain, and should be the subject of future research and data collection:

- Concentration routes, stopover points, flight height and other behaviour of long-distance migrants. Many gaps exist, but the north Kenya coast has been identified as a particular gap in our understanding of the presence and movements of migratory species.
- Vulture movements. The north Kenya coast has again been identified as a particular gap in our picture of vulture presence and movements in Kenya.
- Vulture and raptor nest sites.
- Intrinsic collision risk for Kenyan bird species.
- Information on basic bird and bat species distribution, roost sites, movements and behaviour (including flight heights), seasonal patterns, and susceptibility to collisions for bats.

4.7.2 KEY FINDINGS

- There is a positive policy environment for wind power development in Kenya, and a large number of planned and potential developments are in the pipeline.
- Planning for wind power development has focused on predicted energy needs and the desired energy mix. Environmental considerations have been incorporated only through project-level impact assessment and permitting.
- Wind power can potentially have significant cumulative impacts, especially on wide-ranging or migratory, collision-prone bird and bat species. There is thus the potential for conflict between sectoral policy aims for energy and environment.
- Mapping of biodiversity sensitivity against the wind resource shows that there are large areas of economic wind potential in Kenya where biodiversity risk is likely to be low or manageable. Only 17% of economic wind area pentads are classed as Very High or Outstanding sensitivity for species.
- The bulk of these lower-risk areas of economic wind are in counties in northern and eastern Kenya. Other counties also have areas of good wind resource, but these are relatively small and many pentads show **very elevated risk** (i.e. Very High or Outstanding sensitivity for species and/or sites). Only a few economic wind pentads in Kajiado, Meru and Laikipia have lower biodiversity risk, while all economic wind pentads in Narok are classed as **very elevated risk** for biodiversity.
- Lower-risk areas of economic wind may not have the best wind resource in the country, and may require investment in infrastructure (new roads and transmission lines) in order for developments to be viable.

- Further research would be needed to bring together technical, economic, social and environmental factors to identify the overall 'best bet' locations for future wind development in Kenya. This SEA can inform the environmental component of such a study.
- Species risk (collision-focused) is generally much more widespread and more significant than site risk (footprint-focused) within the economic wind area in Kenya, though this is a general conclusion and varies with locality. This is unsurprising, given that concerns over wind power's potential biodiversity impacts focus mainly on fatalities of sensitive species through collisions, with turbines or transmission lines.
- The majority of current, planned or potential wind power projects are in locations where potential biodiversity impacts should be low, or manageable, based on sensitivity mapping.
- However, a number of current, planned or potential wind power projects are in pentads with **very elevated risk.** These include at least one development in each of Narok, Nakuru, Laikipia and Isiolo counties, three in Marsabit and seven in Kajiado. Meru and (especially) Isiolo also have developments where there are known bat or vulture colonies in at least one adjacent pentad.
- A Potential Biological Removal (PBR) analysis (estimating the number of individuals that can be subject to human-induced mortality without significant population effects) highlights a number of Kenyan species, including threatened vultures, that may be highly susceptible to cumulative impacts of wind farms. For these species, additional wind farm fatalities need to be reduced to as close to zero as possible to prevent negative effects on populations.

4.7.3 RECOMMENDATIONS

The following are key recommendations emerging from this assessment. For each, there is an indication of where the recommendation is addressed, in terms of lead or supporting institutions.

4.7.3.1 PLANNING

- Use the sensitivity mapping presented in this report for risk-screening planned and potential developments for biodiversity risk (bearing in mind that ground-truthing will be needed to confirm the level of risk). Recommended actions to take, according to the level of risk, are outlined in Box 10-2. *Who*: Wind power developers, Ministry of Energy/energy parastatals and NEMA.
- There is particular need to make the findings available and accessible to county-level governments and planners. An initial step could be a workshop to present and discuss results with development and environment planners from counties with high wind energy potential, as these stakeholders have had limited involvement in the exercise so far. *Who*: Ministry of Energy, NGOs, USAID.
- Consider a follow-up exercise to incorporate technical, economic and social considerations, as well as biodiversity, into a spatial strategic plan for wind power development in Kenya that explicitly identifies and addresses trade-offs. This will require a broad partnership between technical experts, NGOs, government and industry. *Who*: USAID/Power Africa Program, Ministry of Energy.

4.7.3.2 MITIGATION

- Introduce a no net loss/net gain project requirement for the highly sensitive biodiversity features, aligned with international good practice benchmarks such as IFC's Performance Standard 6. Some projects are expecting to meet this requirement because of their financing requirements or corporate commitments, but others are not: this requirement would help to level the playing field, and to protect vulnerable species from cumulative impacts at population level. *Who*: NEMA, ERC.
- Consider collaboration to design and implement one or more aggregated offsets to address impacts on a shared suite of sensitive species impacted by wind power. This will improve efficiency and

effectiveness, and reduce the time and cost of design, set up and monitoring. *Who*: Wind power developers, working with the conservation community.

- Consider collaboration for joint industry support of rehabilitation and (where feasible) release of raptors and other large birds. *Who*: Wind power developers, working with the Kenya Bird of Prey Trust and the Raptor Rehabilitation Trust Kenya.
- Develop good-practice national guidelines for mitigation and monitoring of wind power impacts to biodiversity, as a benchmark for wind power developments. *Who*: Wind power developers (industry environmental forum – see 4.7.3.4), NGOs (wind-power forum – see 4.7.3.4).

4.7.3.3 CO-ORDINATION

- Institute an industry environmental forum among wind developers in Kenya, in order to share experience, information and learnings; promote good practice; and interface with regulators, government and the conservation community. *Who*: Wind power developers.
- Develop agreements and mechanisms to share biodiversity survey and monitoring data for wind power developments and offsets, and to standardise data-collection protocols, in order to improve mitigation approaches, cross-project learning and assessment of cumulative impacts. *Who*: Wind power developers.
- Institute a wind-power forum within the conservation, research and consultant community, in order to share experience, information and learnings; promote good practice; and interface with regulators, government and industry. *Who*: the Kenya Bird Conservation Consortium, bird and bat researchers, environmental consultants working in the wind sector.

4.7.3.4 INFORMATION

- Agree on a data repository (preferably an institution with national mandate) and platform to make mapping and the underlying data (where feasible) freely available. Develop mechanisms to update sensitivity mapping regularly with new data and analyses. *Who:* USAID/Power Africa Program, Kenya Bird Conservation Consortium.
- Institute a co-ordinated research and data management program to improve the biodiversity information base and fill identified data gaps in sensitivity mapping. This should include surveys to ground-truth lower-risk areas of economic wind where there is poor biodiversity data, to confirm that risk categorisation is based on reality rather than inadequate data. *Who*: National Museums of Kenya, Kenya Bat Working Group, other researchers, The Peregrine Fund, Nature Kenya Bird Committee, BirdLife International.

4.7.3.5 CAPACITY

- Develop train-the-trainer programs for leaders of on-site biodiversity mitigation teams at wind power developments. *Who*: National Museums of Kenya, The Peregrine Fund, Nature Kenya.
- Develop training programs for national consultants in understanding and implementing good international practice for wind power, in relation to among others risk assessment, identification of priority species, cutting-edge mitigation methods, residual impact assessment, loss/gain accounting, fatality monitoring and offset design and implementation. *Who*: Environment Institute of Kenya, development banks, USAID/Power Africa Program.

5 BACKGROUND AND SEA PROCESS

This SEA Report describes the Strategic Environmental Assessment (SEA) process undertaken for the potential impacts of Kenya's wind power development plans on biological diversity. The energy sector in Kenya is largely dominated by petroleum and electricity, with wood fuel providing the basic energy needs of the rural communities, urban poor, and the informal sector. An analysis of the national energy shows heavy dependency on wood fuel and other biomass that account for 68% of the total energy consumption (petroleum 22%, electricity 9%, others account for 1%). Kenya's objective is to increase the country's installed capacity to 7,213.88MW by 2030 from the current capacity of 2,234.83MW. It is noteworthy that wind and solar will increasingly play a major role in this generation mix during this period, rising from 1.1% to 8.5% and 0% to 8.6%, respectively.

This SEA report follows the requirements of the National Environment Management Authority (NEMA) and other international good practice, especially around the International Finance Corporation (IFC)'s Performance Standard 6. It has been prepared following the Terms of Reference and the scope approved by NEMA in the Scoping Report.

5.1 STRATEGIC ENVIRONMENTAL ASSESSMENT REQUIREMENTS

5.1.1 NEED FOR A STRATEGIC ENVIRONMENTAL ASSESSMENT

Wind power development in Kenya has been accelerated in the recent years due to the need to increase Kenya's power output and improve the energy generation mix by having more 'green' energy, to enable the implementation of Kenya's Vision 2030. This has seen growing interest in wind and solar energy development. While several projects have been initiated or are under planning, each of which has sought and obtained environmental approval through a project-specific ESIA, a Strategic Environmental Assessment (SEA) for the wind power development sector as a whole has not been carried out to date. In most cases, project-specific EIAs or ESIAs do not adequately assess the long-term and cumulative impacts of a development programme or consider strategic alternatives. The Ministry of Energy, with NEMA's approval, has identified that a Strategic Environmental Assessment (SEA) is required to assess and mitigate the existing environmental and social impacts of the wind power sector. With a specific focus on impact on biodiversity, this SEA represents an important first step at fulfilling this key requirement.

The screening and scoping reports for this SEA set out the rationale and need for the assessment in more detail (see

5.1.2 SEA REQUIREMENTS

The SEA for wind power and biodiversity in Kenya was required to comply with Kenya's environmental legal requirements, as outlined in the Environmental Management and Coordination Act (1999), Environmental Management and Coordination Bill (2013) and the Environmental Impact Assessment and Audit Regulations (2003) and the 2012 National SEA Guidelines. In addition, it helps the sector align with international good practice in its operations.

The Environmental Management and Coordination Act (EMCA 1999) is an overarching framework environment law for Kenya. The National Environment Management Authority (NEMA) is mandated under the EMCA 1999 as the principal instrument of the Government on environmental matters. A key NEMA mandate is identifying policies, plans, programmes and projects that are to perform an environmental assessment and provide adequate remedial measures. The Environmental Impact Assessment and Audit Regulations (2003) specifically include Strategic Environmental Assessments as a tool for the assessment of environmental and social impacts at a strategic level, including Policies, Plans and Programmes (PPPs).

In order to ensure compliance with the provisions of the Constitution, some proposed amendments, additional clauses and repealed clauses were recommended for EMCA (1999) as highlighted in the Environment Management and Coordination (Amendment) Act of 2015. According to the amendments, Clause 57A now requires that national, county and trans-boundary plans, policies, projects and programmes be subjected to strategic environmental assessments. NEMA had prepared the National Guidelines for Strategic Environmental Assessment in Kenya (2012) outlining the concept, principles, basic steps and expected outputs and outcomes of the SEA process.

5.1.3 SEA CLASSIFICATION

The National SEA Guidelines classify SEAs as 'ex-ante' or 'ex-post' SEAs depending on whether the strategic assessment is undertaken during the formulation phase of a PPP or to evaluate the results of the PPP implementation. This SEA for wind power development and biodiversity does not strictly fall into either of these categories, since the projects under consideration in the Plan are currently at different stages of development: some are operational or at the commissioning stage, while others are at the design, preliminary or conceptual stages.

5.1.4 OBJECTIVES OF THE SEA

The overarching strategic goal for this SEA is environmental. The key aim was to assess the biodiversity-related impacts (focussing on birds and bats) of planned and potential wind energy development nationally, and recommend appropriate mitigation measures for adverse impacts that could be incorporated into future project-level EIAs. The SEA also makes an initial assessment of existing and predicted cumulative impacts. The SEA aligns with current NEMA guidance and has been conducted with close involvement of relevant Government institutions in both the energy and environment sectors. Specific objectives include:

1. Systematically integrate biodiversity considerations into wind power planning in order to flag up potential biodiversity impacts of wind power development
2. Identify and evaluate alternative wind energy development options, considering the potential impacts on biodiversity
3. Provide recommendations for wind power planning to guide wind investment programmes and ensure planned wind energy development is in alignment with sustainable biodiversity management
4. Identify possible cumulative, indirect or secondary impacts associated with wind power development on biodiversity and propose appropriate mitigation measures.

To achieve these objectives, the SEA process entailed the following key steps or activities:

i. Identify and prioritise sensitive species and sites ('Valued Ecological Components', VECs) through an expert workshop
ii. Identify priority information gaps for VECs and address these as far as feasible through targeted data collection (including fieldwork)
iii. Collate and analyse information on the status and movements of VECs, including extent of suitable habitat maps, from a range of sources, and compile in a GIS database
iv. Undertake sensitivity mapping and modelling against the wind power resource map for Kenya, and existing and potential wind power development plans (including associated infrastructure)
v. Identify areas for lowest potential biodiversity impact and risk for wind power development in Kenya
vi. Identify mitigation and management measures to address potential cumulative biodiversity impact and risk from wind power development

vii. Align with international good practice guidance and draw on lessons learned from similar exercises and processes within Kenya and beyond.

5.1.5 GEOGRAPHIC, TEMPORAL AND THEMATIC SCOPE OF THE SEA

The broad scope of the work is to carry out SEA for wind power development and biodiversity in Kenya. Geographically therefore, this Plan SEA has a national scope, but is entirely focused on onshore wind power development. Offshore wind energy, while growing in importance globally, is not part of current energy development plans in Kenya and was not considered as part of this SEA.

Temporally, the SEA is based on the latest approved Least Cost Power Development Plan 2011-2031, other candidate or ongoing wind power development projects included in the KPGTMP (2015) and draft LCPDP 2017-2037, and potential projects outlined in the 2013 Wind Sector Prospectus (WinDForce 2013). The thematic scope of this wind power SEA is biodiversity, with a focus on birds and bats. On behalf of the Plan owner (Ministry of Energy), the expert research consortium undertook the SEA through a combination of fieldwork, desk research, data analysis and modelling, consultation and workshops with key stakeholders.

Unlike impact-centred EIAs and ESIAs, which propose measures for minimising adverse environment and social impacts, this SEA has a more general focus, operating at the level of mechanisms needed to address potential biodiversity-related impacts that may not be foreseeable or predictable at the time of carrying out project-specific ESIAs, including cumulative impacts. It is thus centred on two key sectors: Energy and Environment (Biodiversity).

From the energy side, while this plan-level SEA primarily focusses on the LCPDP 2011-2031, it also takes a broader look at the energy sector in Kenya, with a focus on wind power development under the renewable energy sub-sector. It assumes a national perspective beyond the projects under the LCPDP in order to respond to other important national plans and policies around renewable energy expansion. These include the new Energy Bill, 2017 (Part IV on Renewable Energy), Kenya's Power Generation and Transmission Master Plan (medium-term and long-term plans) and also Kenya's Action Agenda under the Sustainable Energy for All (SE4All) initiative.

From the biodiversity side, besides being anchored on NEMA's National Guidelines for Strategic Environmental Assessment (2012), it will also examine relevant Environmental Sector policies vis-à-vis wind energy. Significant impacts of wind power development on sensitive or threatened species are counter to Kenya's national conservation objectives, and may breach obligations to international conventions and treaties where Kenya is signatory. This SEA will assess broader issues at national level where sensitive areas for biodiversity may exist in relation to wind power. While considering 'footprint' impacts, it specifically targets flying species (birds and bats) as these have been shown to be most at-risk from wind power development, through collisions with turbines and transmission lines.

5.2 SEA METHODOLOGY AND APPROACH

The SEA process in Kenya is primarily determined by the scale (i.e., Policy, Plan or Programme levels) and the sector that are under consideration. This SEA follows the 2012 National Guidelines for Strategic Environmental Assessment in Kenya and international good practice. The methods employed range from stakeholder consultations to desk research, mapping, modelling and fieldwork. The SEA methodology we employed thus took into consideration three key sources of information for the biodiversity aspects analysed in the SEA:

- **Experts' workshop and fieldwork**: The biodiversity (birds and birds) sites and species data provided by experts or that were collected in the field during the course of this assessment;

- **Stakeholders' views** gathered through a fully inclusive and transparent stakeholder engagement as required by NEMA. This ensured that all relevant stakeholders were aware of and involved (if they wished to be) in the SEA process, and that their concerns were incorporated into the analysis and recommendations;
- **Desk research**: Secondary research on the energy-related and environmental Policies, Plans, Programmes (PPPs) and strategies of the Government of Kenya and of the key stakeholders, and how these affect the proposed wind development plans in the LCPDP. Further wind energy issues such as new technological advancements and biodiversity concerns were studied from published sources from other countries with a more-advanced wind power sector.

Information about the stakeholder engagement process is provided in Chapter 6, and a technical description of the impact assessment methodology and the considered mitigation measures is provided in Chapters 9 and 10. The outline methodology, workflow and institutional structure for the SEA development process are shown in Figure 5-1. Terms of reference for the SEA are provided in A.4.

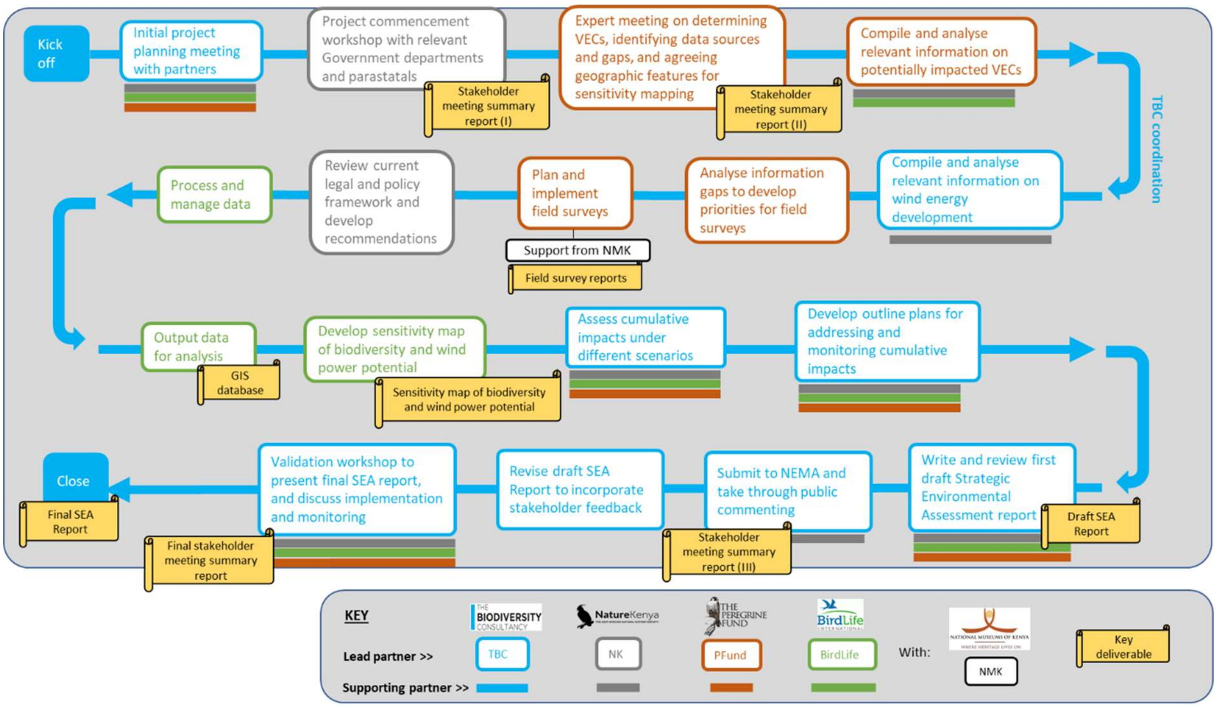

Figure 5-1: Workflow for the Wind Power and Biodiversity SEA process

The appointed team for this SEA combined international and Kenyan expertise, in order to undertake independent, objective and methodologically-robust SEA that ensures that the sustainability of the proposed Plan for key biodiversity is adequately assessed. The methodology and workflow proposed (Figure 5-1) reflected this, and the SEA Team included key experts for each of the main thematic areas (Figure 5-2).

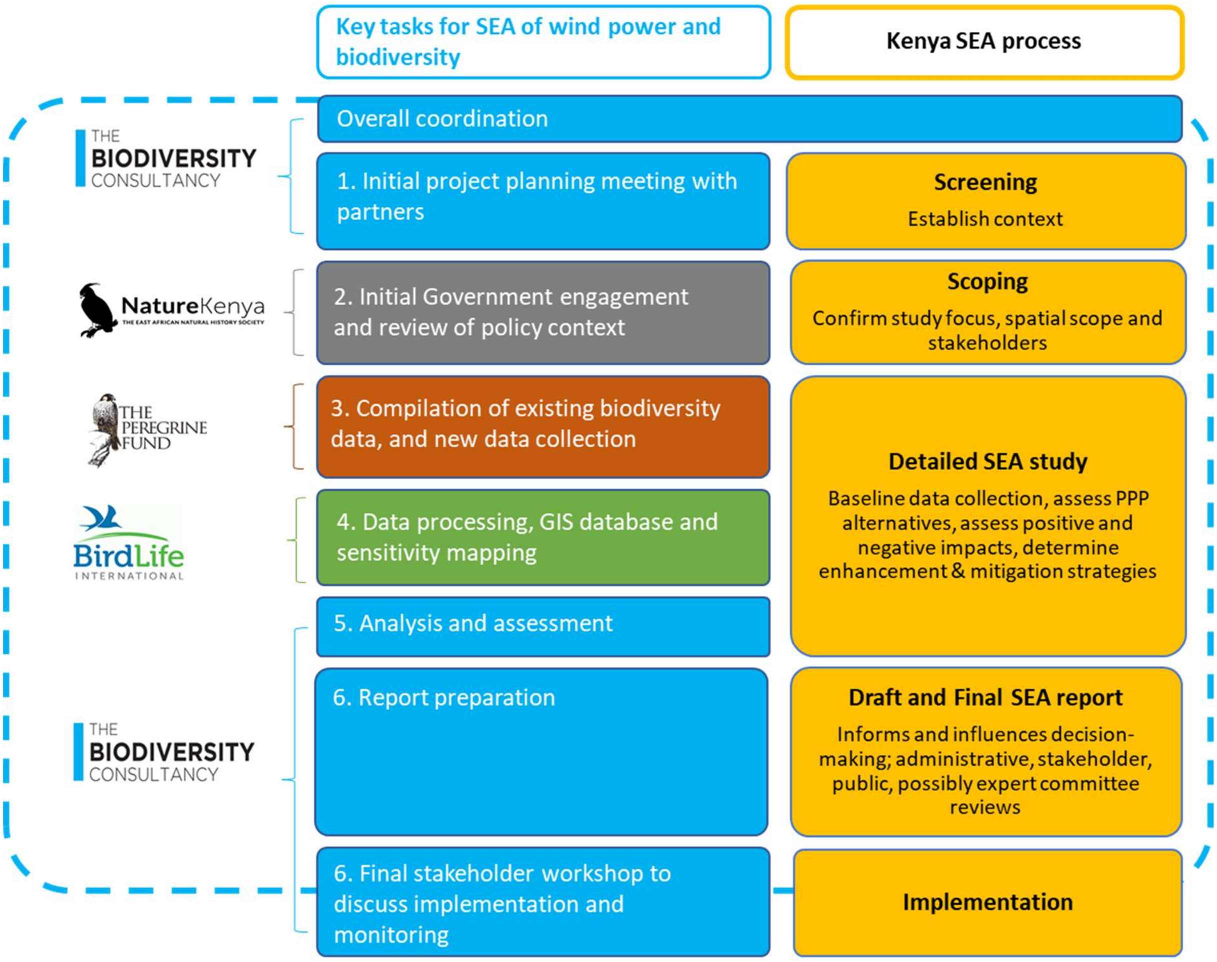

Figure 5-2: Proposed process and institutional arrangement for executing the SEA for Wind Power and Biodiversity in Kenya

5.2.1 CRITERIA FOR IDENTIFYING AND PRIORITISING PRIORITY SPECIES

For identifying priority species and sites, the SEA used the concept of Valued Environmental Components (VECs), which is applied in Cumulative Impact Assessment (e.g. IFC 2013). VECs are environmental and social attributes that are considered to be important in assessing risks. VECs can take many forms, but in this case they are species or the sites that support them. While VECs may be directly or indirectly affected by a specific development, they often are also affected by the cumulative effects of several developments. As sensitive and valued receptors of impact, VECs provide a relevant and manageable focus for assessment, as it is impossible to consider all elements of biodiversity in an assessment.

Species VECs were identified from a candidate list using sensitivity categories for the following criteria (for more details see 9.5.3 and **Error! Reference source not found.**):

- Species' global and national conservation status (referring to, e.g. the IUCN Red List of Threatened Species, and the Regional Red List for Birds) and population trend
- The potential impact of collisions on species' populations, based on demographic characteristics (long-lived, slow-reproducing species are more likely to show population effects from wind farm impacts)
- The likelihood of collision with wind turbines or transmission lines, based on species' size, ecology, behaviour and visual field, and drawing on existing empirical studies and models.

From these attributes, a sensitivity score on a four-point scale (low, moderate, high or very high) was assigned to each priority species, reflecting a combination of its *vulnerability* and its intrinsic *risk of collision*.

5.2.2 CRITERIA FOR IDENTIFYING AND PRIORITISING PRIORITY SITES

Site VECs were identified by the biodiversity expert workshop from a candidate list of site types (for more details see section 9.5.3 and **Error! Reference source not found.**). These site types were selected because they were known or expected to hold significant biodiversity that could be impacted by wind farm footprint and indirect effects. Many site VECs are known or predicted to hold priority species VECs, but this was not the only rationale for inclusion, as footprint impacts could affect many other sensitive species. Collation of site data drew on national inventories of Key Biodiversity Areas, Protected Areas and wetland sites among others.

Once site data had been collated, scores were assigned to each site type, reflecting its significance for priority VEC species where known (see section 9.5.8.6).

5.2.3 FIELD SURVEY PRIORITISATION

Field surveys (see section 9.5.5 and section 9.5.6) to address *information gaps* for priority bats and birds were prioritised via *spatial overlap of the following criteria*:

- Known or predicted concentrations of high-priority species VECs
- Limited recent information on the status and distribution of those VECs
- High wind potential and known or anticipated plans for future wind development.

5.2.4 SYNTHESIS OF INFORMATION

Spatial data on priority species VECs were used to develop a spatial *indicator* of biodiversity sensitivity. This was calculated on a grid-square basis (using the established c. 9 x 9 km pentads of the Kenya Bird Map project). Three components were combined to produce a final sensitivity map, based on a combination of sensitivity scores for the species known or predicted to be present (see details in Chapter 9). These were (a) species location records for birds and bats from observations and specimens, (b) modelled Area of Habitat maps for bird species, and (c) time spent in each pentad by satellite-tagged vultures.

A complementary sensitivity *indicator* was developed for sites, combining scores for the individual site layers to produce an overall sensitivity map.

5.3 KEY PROCEDURAL INDICATORS

Four key procedural indicators were identified:

- SEA to be undertaken following NEMA regulations and guidelines
- Participation of the stakeholders in the SEA consultations (scoping)
- Engagement with stakeholders during implementation (main assessment)
- Publication of relevant information and communication to stakeholders.

6 STAKEHOLDER ENGAGEMENT

6.1 STAKEHOLDER MAPPING

Public Participation and Stakeholder Engagement are integral parts of the SEA process. A systematic approach to identifying affected stakeholders is considered best practice. The stakeholder analysis was undertaken in the scoping stage of the SEA and is detailed in the Scoping Report approved by NEMA (see A.8). This wind power SEA was designed as a highly participatory process that provided multiple opportunities to government agencies, civil society and wind-power developers for contributing to the process and final product. Stakeholders were identified using a combination of existing knowledge of the two main sectors under the SEA.

Because this SEA had a national scope, stakeholder engagement was focused at that level. The range of stakeholders involved spanned government, civil society, academia, investors and wind-power developers.

The technical scope for stakeholder consultations focused on wind energy and biodiversity, particularly birds and bats. For biodiversity, the SEA expert technical consortium used their prior knowledge to identify key stakeholders in Kenya, particularly bird and bat experts, across NGOs, Universities and Government. For wind-power development, the Plan owner (the Ministry of Energy and associated state agencies, especially the ERC) was supported by USAID's Power Africa Transactions and Reform Programme to undertake a stakeholder analysis for the wind development sector. These included government authorities and state corporations in the environment and energy sectors, civil society and private sector agencies (both investors and wind power developers) whose area of interest is related to the Plan.

6.2 STAKEHOLDER ENGAGEMENT STRATEGY AND COMMUNICATION TOOLS

Stakeholder engagement and communication strategy took into consideration the issues and messages to be communicated to the broad range of stakeholders, with the key goal being to inform and update them about Kenya's broad wind power development plans and how they may impact biodiversity, then collect their views and concerns about it for the purpose of SEA. The approach recognised that there is a particularly diverse set of expert stakeholders for this SEA, which deals both with some highly technical biodiversity issues and with practical project implementation by the wind energy sector. The stakeholder engagement and communication plan was built around the following key steps, in alignment with NEMA Guidelines:

- **Biodiversity Expert Workshop**: for identification of key species and sites (Valued Environmental Components) as well as gaps in knowledge. Outputs of the workshop were circulated for information and review, and interaction has continued with a number of biodiversity experts over the SEA's development.
- **Government engagement process**: for mainstreaming of the process and settling on the primary owner and user of the final product. This involved a series of meetings and discussions with Ministry of Energy, ending in agreement that MoE would be the primary owner of the SEA process and would convene and host a stakeholder scoping workshop jointly with USAID. The MoE has continued close involvement with shaping the SEA's scoping and screening reports and with convening and hosting subsequent stakeholder meetings.

- **Scoping stage consultative workshop**: for identification of key issues to be addressed under the SEA, plus further analysis and segmentation of major stakeholders across the wind development sector. This aimed to help revise the scope or focus of the SEA and help improve (within NEMA Guidelines) the proposed engagement plan.
- **Consultative stakeholder meeting** to gather stakeholder input on the 'zero draft' of the SEA report and its key findings.

The process from here will follow NEMA guidance via:

- Public comments on Draft SEA report: internal (NEMA) and external stakeholder engagement for detailed comments on the draft SEA Report. To ensure that public engagement is meaningful and not just a case of providing stakeholders with detailed information, the SEA engagement process requires that these comments are checked by NEMA and incorporated into the Final SEA, which is cross-checked during the validation workshop
- Validation workshop: full stakeholders' workshop for presenting the final version of the SEA Report.

6.3 STAKEHOLDER ENGAGEMENT AND VIEWS

The multi-step approach to establish and maintain an ongoing dialogue with the stakeholders has so far included three major consultative workshops. The summary outcomes from the three workshops are outlined below (extended Minutes are available in A.9, A.10 and A.12, respectively).

6.3.1 BIODIVERSITY EXPERT WORKSHOP

Taxon-specific specialists were invited to an opening workshop on 13 March 2018 at National Museums of Kenya to help in the identification of key species and sites (Valued Environmental Components) as well as gaps in knowledge for the key biodiversity considered in the SEA (birds and bats). The workshop was also attended by representatives from Ministry of Energy and USAID's Power Africa programme. Participants numbered 27 in all. Outputs from this workshop were crucial in defining the focus for data collection and analysis for the assessment. The workshop report is provided in A.9.

Species and site VECs were identified from the workshop which were further reviewed and consolidated for the SEA. Valued Environmental Components (VECs), are the key species and sites on which the SEA would focus, considering potential sensitivity to wind power impacts (based on conservation status and risk of collision), and their occurrence and distribution in Kenya.

For birds, most raptors and vultures were considered at high risk due to their soaring behaviour, migratory and congregatory tendencies and fast flights; owls were considered generally low-risk. Other bird species like waterbirds and cranes were considered at moderate to high risk, especially if they were migratory

For bats, four groups were considered most at-risk: fruit bats, sheath-tailed bats, free-tailed bats and long-fingered bats. This was due to a combination of their flying, foraging, roosting and migratory behaviours

For sites, the key sites considered as VECs were based on topography (cliffs and scarps), nesting and roosting sites (including caves for bats), IBAs/KBAs, wetlands and migratory bottlenecks.

6.3.2 CONSULTATIVE SCOPING WORKSHOP

This workshop (Norfolk Hotel, 22 August 2018) was held at the scoping stage to get initial thoughts and feedback from key stakeholders about the proposed SEA, and to identify industry needs and any major gaps. A total of 43 participants attended across ten stakeholder categories: national government (both energy and environment sectors), county government, NGOs, investors and lenders, wind power developers, consultants, academia, aviation sector, and media.

Ten key issues pertaining to wind energy and biodiversity were raised, with several points pertaining to the scope of the proposed SEA: these were responded to and agreed upon during the workshop and/or addressed in the content of the Scoping Report. The workshop report is provided in A.10.

6.3.3 CONSULTATIVE MEETING ON SEA FINDINGS:

The second consultative workshop (National Museums of Kenya, 12 March 2019) was convened to discuss the key results from the zero draft of the Full Report. The main objectives of this meeting were (i) to update sector players on progress that the SEA Team had achieved, (ii) to present key findings from the study and initial recommendations of the draft wind power and biodiversity SEA, and (iii) seek input from sector players on the zero draft SEA, particularly to help with consolidating recommendations. Fifty-four participants attended this meeting held at the National Museums of Kenya, from a diverse array of stakeholder categories including: national government (both energy and environment sectors), county government, NGOs, investors and funders, wind power developers, consultants, academia and researchers, and the media. Following comments at the first consultative workshop, effort was made to ensure that all major industry developers were invited, and at least nine companies were represented. The 'zero draft' SEA report and annexes were circulated in advance of the meeting for stakeholders to review. Some 25 key issues, questions and reactions were raised during the workshop which were addressed both during the meeting and subsequently incorporated into the revised Full SEA Report, including a major additional analysis of findings at county level. The workshop report is provided in A.12..

7 DESCRIPTION OF PROPOSED PLAN

7.1 GLOBAL WIND ENERGY SECTOR

Growing concerns about the negative impacts of fossil fuel use coupled with advances in renewable technology have initiated a major transformation of energy systems around the globe. The trend towards clean, affordable and reliable power remains one of the key drivers behind the growth in renewable energy[7]. Wind energy is one of the most mature renewable energies in terms of commercial exploitation. Being carbon emission free during operations, it contributes relatively little to global warming. Because wind power requires substantial capital, governments around the world have been providing subsidies and incentives to encourage private investors. Strict environmental regulations also supported the renewables market, particularly in matured markets in Europe and North America. These initiatives have substantially helped the wind power industry, as have technology advancements bringing down generation costs. New markets are developing rapidly across Africa, Asia and Latin America, supplying clean energy to support sustainable development.

Wind energy is one of the fastest developing energy technologies across the globe, with numerous efforts to harness wind energy on a utility scale, and technology advancements bringing down generation costs. New markets are developing rapidly across Africa, Asia and Latin America, supplying clean energy to support sustainable development. With dramatic price decreases in recent years for wind, solar and other renewables, a decarbonized power sector is now considered not only technically feasible, but is economically competitive as well.

Wind power is now considered to be in a rapid transition towards becoming a fully commercialised, unsubsidised technology successfully competing in the marketplace against heavily-subsidized fossil and nuclear incumbents (GWEC 2018). The transition to fully commercial market-based operation has meant that the industry is going through a period of adjustment and consolidation. Across the globe, there is a transformation of markets for wind power away from the support schemes that gave birth to the industry, with wind taking its place as a purely commercial technology, increasingly operating without subsidies or support mechanisms.

The global wind power market remained above 50 GW in 2017, with Europe, India and the offshore sector all having record years[8]. Although Chinese installations were down, the rest of the world made up for most of that; total installations in 2017 were 52,492 MW, bringing the global total to 539,123 MW (GWEC 2018). The proportion of wind power in the total power market doubled from 2% in 2011 to 4% in 2017, and is expected to further increase over the short-to-medium term (GWEC 2018). private-sector power purchase

It is expected that growth in capacity additions will decelerate due to maturity and the transitioning from a subsidy-based industry towards an open competitive based market. The slowdown in growth belies falling costs as it also emerges as an open market-based industry now entering competitive auctions. A major

[7] Global Wind Energy Market Outlook 2018-2028: https://www.marketwatch.com/press-release/global-wind-energy-market-outlook-2018-2028---researchandmarketscom-2018-09-06

[8] https://gwec.net/global-wind-power-2017-market-and-outlook-to-2022/

competitor for the wind power is the solar energy, whose own advancements and growth will affect the wind power market share in the coming years.

While the future of renewable power is considered to lie in hybrid systems, emphasis is shifting to emerging issues including (green) certification of wind power projects, storage solutions and end-of-cycle disposal of wind blades which is considered a complex engineering problem. Lastly, wind mini-grids may gain prominence as is it realised that, for governments and donors aiming to connect rural citizens, mini-grids will increasingly offer a more cost-effective route than conventional grids.

7.2 CHALLENGES FOR WIND ENERGY IN AFRICA

Three main potential areas of concern have been identified for the wind energy industry in Africa: policy, technical and economic[9]:

- **Policy**: to thrive, the wind industry sector requires a clear strategic and regulatory framework. Only the North African countries and South Africa have implemented a clear plan to boost the industry. Under the momentum of international agreements like the Paris Accord most African nations have established renewable energy targets – some even going further with a quota for wind – but there is still a big gap between that and pro-active implementation.
- **Technical**: like solar, wind is an intermittent energy source that cannot easily be predicted or stored. These two shortcomings mainly explain why wind is not considered reliable enough for baseload supply. Without potential for storage, the whole management exercise is about balancing supply and demand. As an illustration of the integration problems faced by transmission networks, when the wind blows over a wind farm and delivers electricity to the grid, that load must be carried to a destination, whether a customer has been identified or not, and whether the transmission and distribution system can absorb it or not. The intermittency of wind implies that large-scale wind farms will require significant back-up plans.
- **Economic**: Assessing the economic viability of wind power generation is paramount in evaluating the growth potential of the industry. While renewable energy costs are decreasing, capital costs are still a major financial issue for wind power, and still represent close to 75% of most budgets.

7.3 WIND ENERGY IN KENYA

7.3.1 THE CURRENT ENERGY MIX

This SEA is designed to support the general wind development sector in Kenya, specifically by helping integrate biodiversity considerations into decisions that relate to wind power development. Energy is one of the key enablers of the Vision 2030 and energy security remains a matter of national priority. Towards this end, the Government of Kenya is working to ensure universal access to modern energy services, doubling the global rate of improvement in energy efficiency and doubling the share of renewable energy (RE) in the national energy mix by 2030 (SEA 2016)[10].

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[9] https://www.esi-africa.com/the-state-of-wind-energy-in-africa/

[10] https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_IPs/Kenya_SE4All_IP_January_2016.pdf

The energy sector in Kenya remains dominated by wood fuel (biomass: 68%[11]), which provides the basic energy needs of the rural communities, urban poor, and the informal sector. Petroleum provides 22% of energy requirements and electricity just 9%.

Currently, electricity is mainly generated from hydropower, geothermal and thermal (Table 7-1). As hydropower has proved unreliable, current government plans for the energy sector favour development of wind, thermal and geothermal generation. Wind and solar are expected to play a significant role in national energy matrix in Kenya in the future (IEA 2015)[12]. Kenya's objective is to increase the country's installed electricity capacity to c. 7,200 MW by 2030 from the current capacity of c. 2,200 MW, with wind and solar increasingly prominent in this new generation mix. The greater emphasis on wind and solar, both on and off grid, will support Kenya's climate change mitigation commitments, and also reduce wood fuel dependence and ameliorate the serious environmental pressures this creates (SE4All 2016)[13].

[11] 2007 figure: current data are not available, but this proportion is likely to have decreased as many more households now do have access to electricity.

[12] https://www.africaportal.org/publications/situational-analysis-of-energy-industry-policy-and-strategy-for-kenya/

[13] https://www.seforall.org/sites/default/files/Kenya_AA_EN_Released.pdf

Table 7-1: Installed power generation capacity in Kenya as at 31 December 2018 - Source: Ministry of Energy (MoE)

Source	Installed MW	% Share
Hydro	826	30.4%
Geothermal	663	24.4%
Thermal (MSD$^{\alpha}$)	748	27.6%
Thermal (GT$^{\beta}$)	60	2.2%
Biomass	28	1.0%
Solar	51	1.9%
Wind	337	12.4%
TOTAL	**2,712**	**100%**

$^{\alpha}$Medium Speed Diesel
$^{\beta}$Gas Turbines

According to the Ministry of Energy, the installed capacity of grid-connected wind energy at the end of 2018 was 337 MW, while the installed capacity of wind hybrids in off-grid stations is estimated at about 0.55 MW. Significant potential for wind power development exists in Kenya, with wind resource assessments indicating a total technical potential of 4,600 MW (WinDForce 2013). The 300 MW Lake Turkana Wind Power project is the largest single wind farm in Africa, while the 5.1 MW Ngong Hills Wind Farm was expanded in 2016 to 25.5 MW. Some 20 additional projects, totalling around 900 MW further capacity, are currently in the pipeline. Boosted by the completion of the Lake Turkana project, the present contribution of wind as a source of electricity in Kenya is about 12.4%.

To stimulate growth of the renewable energy sector, the Government of Kenya (GoK) plans to invest up to US$ 50 bn over the next 20 years in order to cope with the predicted 13.5% annual increase in electricity demand (ERC 2018). Candidate generation resources considered in the system expansion plan are mainly renewables including geothermal, wind and solar. In these investment plans, wind is going to continue to play a vital role in meeting the continuously increasing demands of the country (Figure 7-1Figure 7-1: Amount of annual additional generation capacity predicted based on committed and candidate generation projects and their estimated Commercial Operation Dates (COD) – Source: LCPDP 2011-2031, KPGTMP 2015 and draft LCPDP 2017-2037).

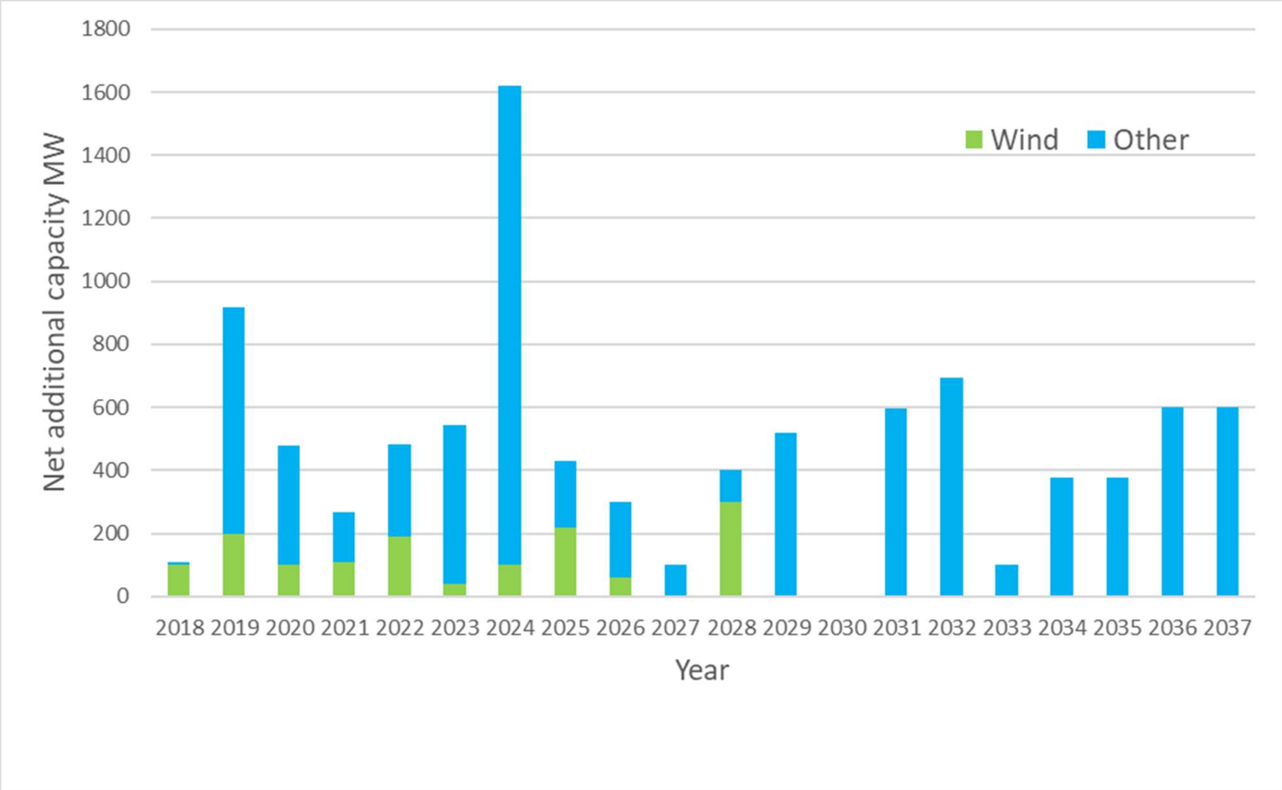

Figure 7-1: Amount of annual additional generation capacity predicted based on committed and candidate generation projects and their estimated Commercial Operation Dates (COD) – Source: LCPDP 2011-2031, KPGTMP 2015 and draft LCPDP 2017-2037

7.3.2 WIND RESOURCE AND POTENTIAL

When considering the potential for wind power, it is essential to distinguish between theoretical and technical potential. Theoretical potential only considers availability of the raw resource without considering spatial restrictions and other aspects like conversion efficiencies (and losses) in the system. Assessment of theoretical potential often involves a simple geographical assessment that considers areas that are suitable for wind energy deployment based only on their wind resource. Assessment of technical potential then incorporates the other elements needed to enable wind energy development.

7.3.2.1 KENYA WIND ATLAS 2004

The Kenya Meteorological Department undertakes wind measurements at 35 stations spread out in the country. These measurements are carried out at 10 m above ground level, mainly for agro-meteorology and civil aviation purposes (SWERA 2008). Using data from these stations, the Ministry of Energy developed a Wind Atlas in 2003 (MoE 2004) to provide investors with indicative data on the strength and location of wind resources in Kenya (Oludhe 2008). Average wind speeds of >5 m/s indicate good potential for wind energy development (SWERA 2008). The initial Wind Atlas located about 10-13 good sites across Kenya with wind speeds of >7 m/s (MoE 2004).

7.3.2.2 WIND ENERGY PROSPECTUS FOR KENYA

The sparse network of meteorological stations constrained the resolution of mapping in the 2003 Wind Atlas. Research to augment this information was started by GoK in 2008 for *Wind Energy Data Analysis and Development Programme* under the Energy Sector Recovery Project supported by the World Bank. Ninetyfive (95) wind masts and data loggers were installed across the country, covering all seasonal parameters, with wind speed sensors installed at heights of 20 m and 40 m above ground level[14]. The process of updating the Wind Resource Atlas for Kenya was initiated in 2013 based on data from these 95 wind masts, starting with a prospectus to guide Kenya's strategy for harnessing its wind resource undertaken by WinDForce Management Services Private Limited. For future assessments, WinDForce recommended installation of additional, taller wind masts in 18 high-potential areas. The Government installed 18 wind masts at a height of 100 m, with sensors at three levels: 100, 80 and 60 m, better reflecting the average hub heights of most currently recommended wind turbines. This enables collection of more accurate data that will enable undertaking detailed feasibility studies in readiness for future wind development, including supporting policies like the proposed Renewable Energy Auctions.

[14] http://energy.go.ke/?p=343

Box 7-1: Wind resource assessment

There are various ways of analysing wind power development potential for an area. On the one hand, prospective developers can work from sites of adequate wind potential, and examine if there are any constraints that can be avoided or mitigated for. Alternatively, developers seeking to find wind sites can undertake a 'sieve analysis'. This involves mapping all the various physical, environmental, technical and policy constraints that would make a site unsound for a wind turbine, leaving a patchwork of areas that might be suitable (i.e., candidate sites) that are then considered in further depth (CSE 2016). Constraints which would prevent a wind turbine from being developed include protected areas and landscapes, designated heritage areas or assets, wildlife sites or protected species, major public infrastructure, aviation and exclusion areas (e.g., military bases) and major residential areas that could be affected by noise and shadow flicker exposure.

The wind is a highly variable resource, both in time and space. The wind speed is extremely important for determining the amount of energy a wind turbine can convert to electricity. A key consideration is that the available power is proportional to the cube of the wind speed; doubling wind speed yields an eight-fold increase in power. This cubic relationship is the single most important point relating to the assessment of the wind resource. Wind speed generally increases with height above ground. As a rule of thumb, wind speed of 5-6 m/s at 45 m above ground level is the minimum considered to have potential for commercial wind energy development; any sites with an annual mean wind speed below 4 m/s are unlikely to be economic even for small scale power generation.

A wind turbine obtains its power input by converting the force of the wind into a torque (turning force); thus, the amount of energy in wind depends on the wind speed, rotor swept area and density of the air. The 'heavier' the air, the more energy is received by the turbine, and the larger the rotor, the more energy it can capture. Air density changes slightly with air temperature and more noticeably with elevation. Wind power density (WPD) is therefore a useful way to evaluate the wind resource available at a potential site, as it indicates how much energy is available at the site for conversion by a wind turbine. Measured in watts per square meter, it is the mean annual power available per square meter of swept area of a turbine, calculated for different heights above ground and incorporating the effect of wind velocity and air density. It is thus the effective force of the wind at a location.

Wind potential is often depicted through 'Wind Power Classes' instead of mean annual wind speeds. It is important to note that the wind speeds that these classes relate to depend on the reference height. The wind power class of a wind turbine is a rating system that is used to rank the quality of the location of a wind turbine and the average wind speed of that location. The higher the wind power class number, the more acceptable the site location will be for a wind project. In general, commercial wind power development is considered to become feasible around wind power class 4. Wind turbines are manufactured for a specific Wind Class. A Wind Class 3 turbine is designed for sites with average wind speeds of up to 7.5 m/s; they typically have extra-large rotors to allow them to capture as much energy as possible from the lower wind speeds they are subjected to. Wind Class 2 turbines are for windier sites up to 8.5 m/s average, and are the most common class of wind turbines available. Wind Class 1 turbines are designed to cope with the tough operating conditions experienced at sites with average wind speeds above 8.5 m/s .

Though modern wind turbines capture wind ever more efficiently, most only have efficiency ratings of between 20-50% of rated power output, which is the maximum amount of power the turbine could produce if it ran all the time. Plant load factor (also known as capacity factor) refers to the ratio between the actual energy output from a turbine divided by the theoretical maximum output, if it were running at its rated (maximum) power during all of the 8766 hours of the year. The amount of energy produced is reduced by efficiency and wind availability which determines the percentage of time the unit has enough wind to move. For example, if a five-megawatt wind turbine produces power at an average of two megawatts, then its capacity factor is 40% (2÷5 = 0.40, i.e. 40%). An estimate of the annual energy output in kWh/year is the best way to determine energy output from a wind turbine (Lee 2018).

During wind assessments (see Box 7-1), as one moves from annual average wind speed to wind power density to capacity factor and annual energy output, the results become more specific to a given site and turbine model. For this SEA, we used wind power density to evaluate the raw wind resource in Kenya. This measure provides the best balance for this assessment, being more informative than the mean wind speed alone but not restricted to specific turbine characteristics. Where necessary to specify turbine heights and wind class during the sensitivity analyses, we used 80 m, as most modern turbines are in the 60 – 100 m range (e.g., WinDForce 2013). For wind power density, unless otherwise stated, we apply the wind power scale in the Wind Energy Resource Atlas of the United States (NREL 1986) (Table 7-2).

Table 7-2: Wind power scale in the Wind Energy Resource Atlas of the United States

Wind Power Class	Wind Power Density (W/m^2)	Speed m/s
1	0-200	0-5.6
2	200-300	5.6-6.4
3	300-400	6.4-7.0
4	400-500	7.0-7.5
5	500-600	7.5-8.0
6	600-800	8.0-8.8
7	800-2000	8.8-11.9

To evaluate the impacts of wind development for biodiversity in Kenya, we start from identifying areas with an adequate wind resource then focus on these to determine if any potential biodiversity-related constraints that may preclude wind power development and how these may be overcome. To compute annual mean wind speed, the *Wind Sector Prospectus for Kenya* (WinDForce 2013) used the wind speed data from the 40-m level wind sensors, adjusted to 60, 80 and 100 m and incorporating seasonal and spatial variability (see Fig. 4 for 80 and 100 m maps).

Average wind speeds in large parts of the country exceed 6 m/s (

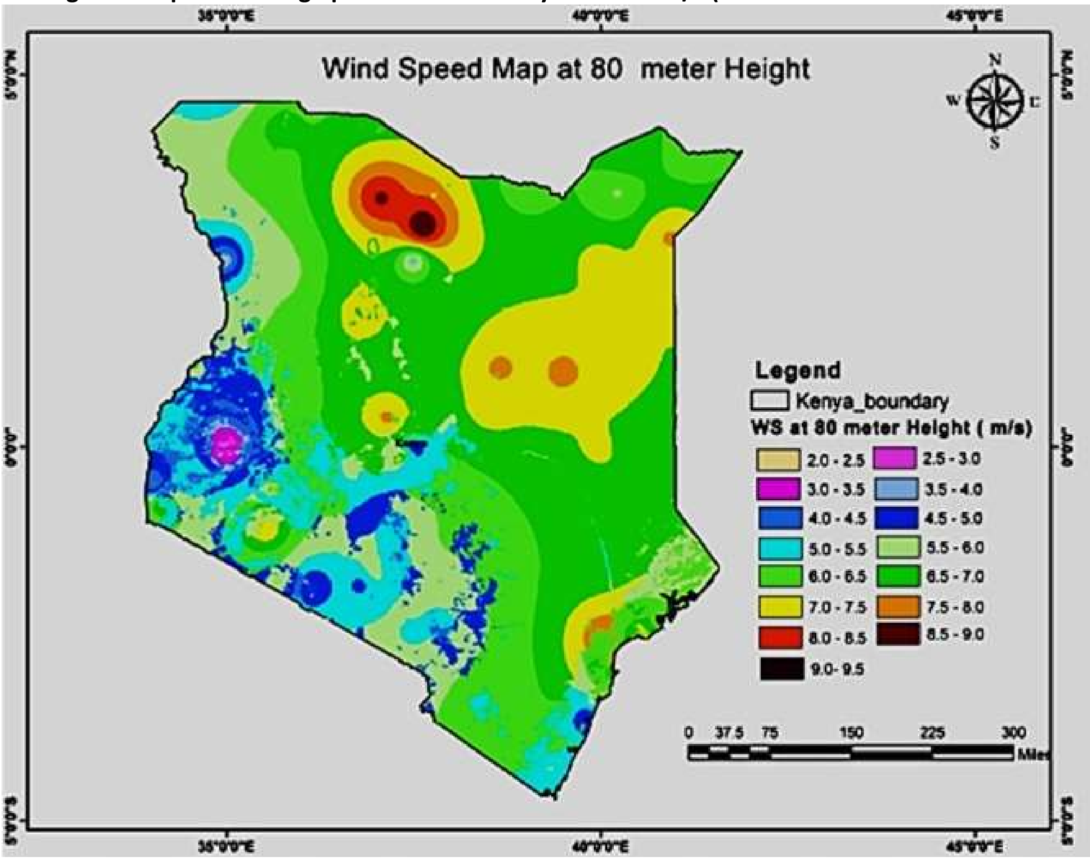

Figure 7-2). Overall, Marsabit County clearly has most of the best wind areas in Kenya (based on raw wind potential and not considering other potential constraints), while some other good wind pockets occur in Samburu and Laikipia Counties, the north of Meru County, Nyeri and Nyandarua Counties and the Ngong Hills; other wind hotspots are Lamu, Loitokitok at the foot of Kilimanjaro and the Narok plateau (SWERA 2008; WinDForce 2013) (Figure 7-3).

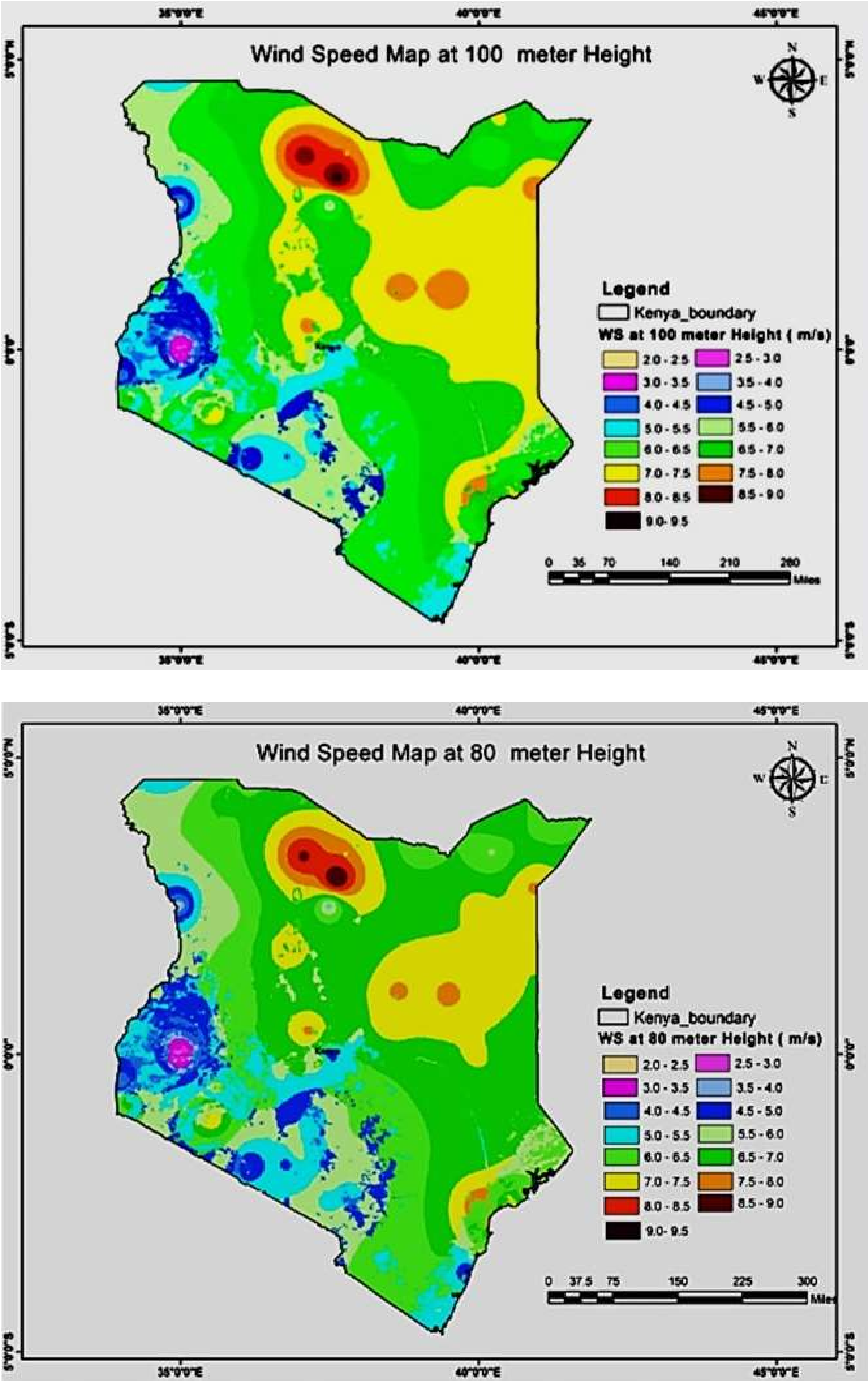

Figure 7-2: Wind speed maps of Kenya developed by WinDForce at 80 m and 100 m heights (WinDForce 2013)

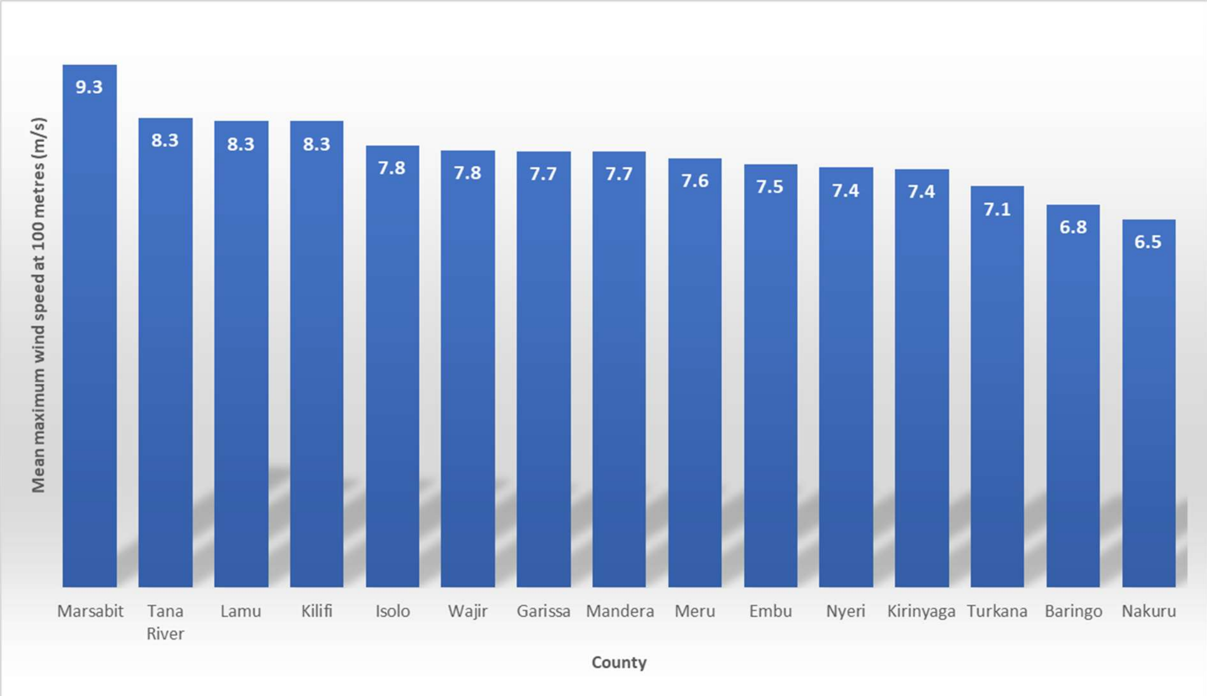

Figure 7-3: Top counties in mean maximum wind speeds at 100 m above ground level, based on WinDForce (2013)

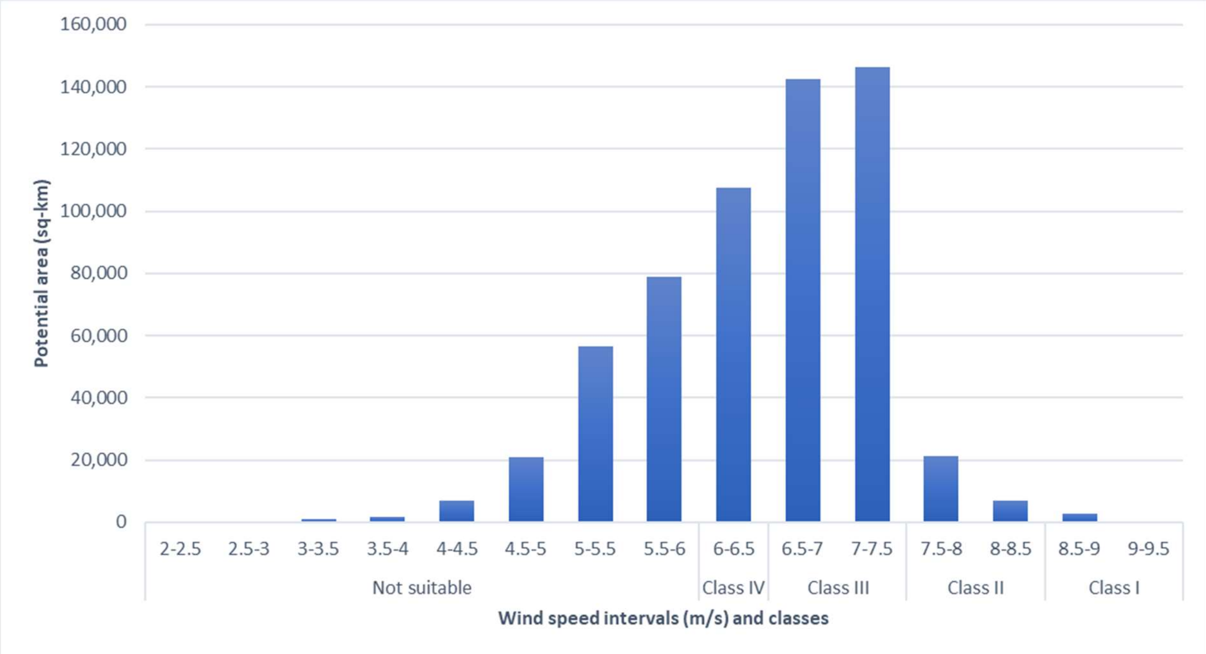

Figure 7-4: Area in Kenya under different wind speed classes at 100 m above ground level, based on WinDForce (2013)

WinDForce further categorised wind speed into four classes: Class I (>8.5 m/s); Class II (7.5 - 8.5 m/s); Class III (6.5 – 7.5 m/s), and Class IV (6 – 6.5 m/s), and computed wind power density (WPD; see description in Box 7-1) for the country at each 1 km^2 and for the three heights (60, 80 and 100 m). WPD was categorised as poor (< 150 Watt/m^2), fair (150-250 Watt/m^2), good (250-350 Watt/m^2), or excellent (> 350 Watt/m^2).

This national potential for wind generation in Kenya is considered one of the highest in Africa[15] (GoK 2014, GIZ 2015). Overall, it is projected that with middle to large wind turbines, a total of over 1 GW could be achieved from Kenya's raw wind resource potential (GIZ 2015).

Based on WinDForce's pre-feasibility study in terms of annual energy output (see description in Box 7-1), eight wind sites were identified as high potential for generating wind energy using various wind turbine models in the country: Baragoi, Garissa, Habasweni, Hola, Laisamis, Maikona, Narok and Ngomeni (for map, see Figure 7-11). They all had mean wind speeds above 5 m/s, and plant load factors[16] in the range of 25-40% using Class II wind turbine models[17].

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[15] 2004: Sessional Paper No. 4 on Energy, MoE, GoK

[16] Plant Load Factor (PLF) is the ratio between the actual energy generated by the turbine to the maximum possible energy that can be generated while working at its rated power for a designated duration. Also known as the capacity factor, it is the average power generated, divided by the rated peak power. For example, if a five-megawatt wind turbine produces power at an average of two megawatts, then its capacity factor is 40% (2÷5 = 0.40, i.e. 40%)

[17] WinDForce computed Plant Load Factors for these eight sites based on the following five Wind Turbine Generator (WTG) models: GE - GE103 with 80 m hub height, Vestas - V100 with 80 m hub height, Gamesa 97 with 78 m hub height, Sinovel82 with 80 m hub height and Suzlon97 with 90 m hub height.

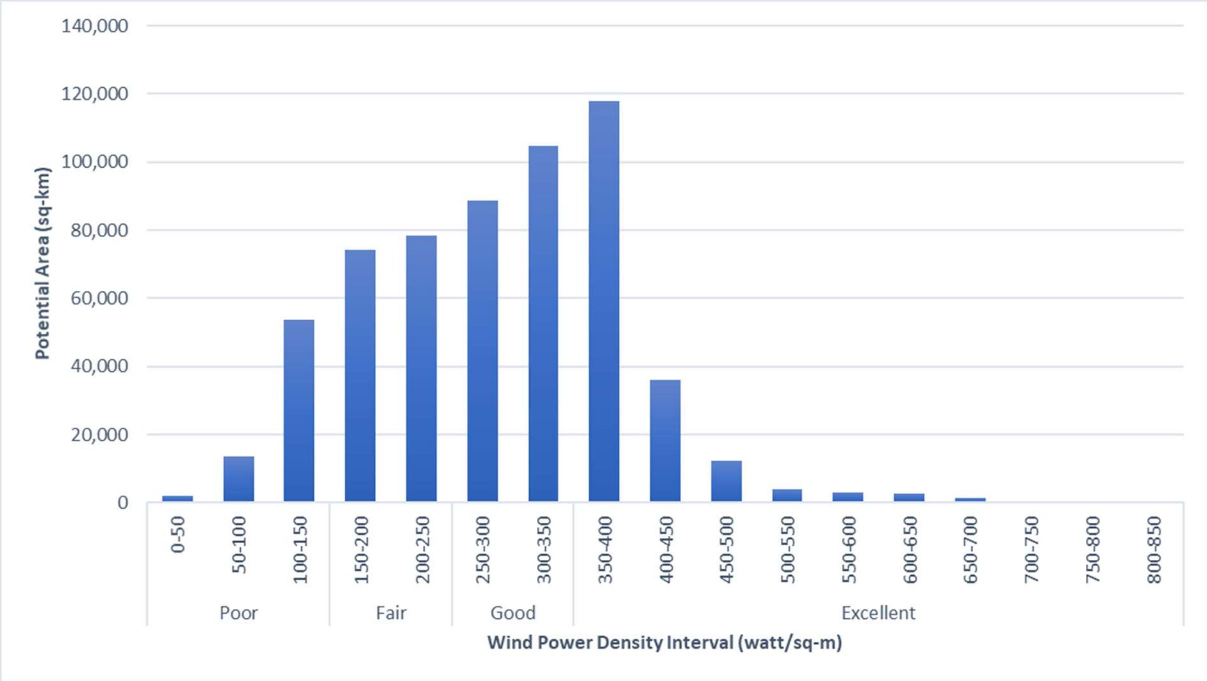


Figure 7-5: Area in Kenya under different wind power densities at 100 m above ground level, based on WinDForce (2013)

7.3.2.3 GLOBAL WIND ATLAS

For this SEA, in addition to these data based on in-country masts and analysis by WinDForce, we also referred to global datasets from the Global Wind Atlas (GWA)[18] (Box 7-2). Datasets used in the GWA are chosen from the best available global datasets for each required category. This means the datasets needed to both be of high quality, but also have high enough resolution to enable accurate downscaling (see Box 7-2). Besides these data providing a better spatial resolution for use in these analyses, and are globally consistent thereby enabling comparisons of this SEA to other similar analyses in the region and worldwide.

[18] The Global Wind Atlas 2.0, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU) in partnership with the World Bank Group, utilizing data provided by Vortex, with funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info

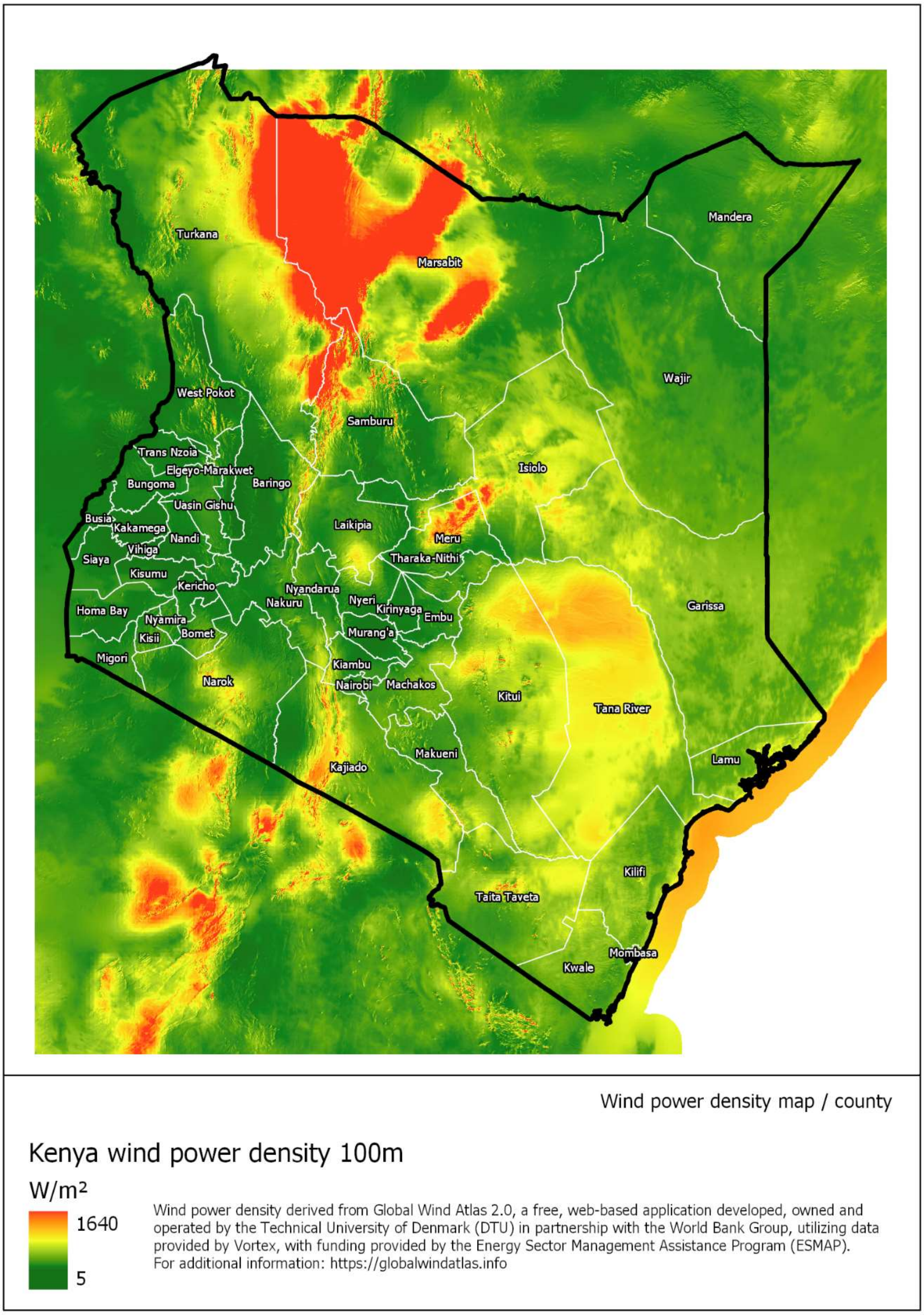


Figure 7-6. Global Wind Atlas modelling of Kenya wind power density at 100 m, with county boundaries

Box 7-2: Global Wind Atlas

Overview

The Global Wind Atlas is a free, web-based application developed to help policymakers and investors identify potential high-wind areas for wind power generation virtually anywhere in the world, and perform preliminary calculations. Users can download high-resolution maps showing global, regional, and country wind resource potential. This new version of the Global Wind Atlas (GWA 2.0) is the product of a partnership between the Department of Wind Energy at the Technical University of Denmark (DTU Wind Energy) and the World Bank Group (consisting of The World Bank and the International Finance Corporation, or IFC). Work on GWA 2.0 was primarily funded by the Energy Sector Management Assistance Program (ESMAP), a multi-donor trust fund administered by The World Bank and supported by 13 official bilateral donors.

Purpose

The Global Wind Atlas (GWA) primarily supports wind power development during the exploration and preliminary wind resource assessment phases, prior to the installation of meteorology measurement stations at a site. It can assist governments to get a better understanding of their wind resource potential at provincial and local levels, as well as and investors identify potential high-wind areas for wind power generation worldwide. It enables users to download high-resolution maps showing global, regional, and country wind resource potential, including power density and wind speed maps for the world and a selection of countries and regions.

Methods

The GWA uses a downscaling process that begins with large-scale wind climate data and ends with microscale wind climate data. The large-scale wind climate data is provided by atmospheric re-analysis data that are located on a grid with a spacing of about 70-km. these data are used to build the mesoscale model using a grid spacing of 9-km. Performing a generalization process on this data results in a set of wind climates that have the same spacing as the mesoscale data that was used to create them.

This set of generalized wind climates are then applied to a microscale modelling system over the globe, with the only exceptions being the North and South Poles and far offshore ocean areas. The modelling process is made up of a calculation of local wind climates for every 1km at three heights: 50, 100 and 200m. Thus, there is a local wind climate estimate for every node of a 1km grid across the globe.

7.3.2.4 IRENA MULTI-CRITERIA ANALYSIS

There is unlikely to be wind power development except where there is economically viable wind resource. However, wind resource is not the only factor that determines the siting of wind power developments. IRENA’s MultiCriteria Analysis for Planning Renewable Energy uses the methods of Wu et al. (2016) to determine the economic viability of potential wind farm locations. This is a function of the wind resource and (among other factors) distance to potential and planned transmission lines.

After researching the attributes calculated by Wu et al. (2016), we selected for mapping the attribute *Electricity generation discounted chosenTurbine MWhPerYr* (electgen_c). This is a measure of wind using the optimally selected IEC turbine class for that square and assuming a 75% land use discount factor[19].

IRENA's resource quality threshold for identifying these economically-viable zones is 250 W/m^2. Industry stakeholders have commented that this is less than the preferred wind energy density for currently planned developments. However, some developments already in the pipeline are in counties with maximum wind energy densities below this threshold (see section 7.4.2). In future, there may also be need to consider trade-offs in siting between biodiversity impacts (and associated mitigation costs) and optimal wind energy potential.

Figure 7-7 shows the map of economically-viable wind areas for Kenya, mapped onto the pentad grid used for sensitivity analysis (see section 9.6.7). Values in the pentads selected by the multicriteria analysis range from c. 12,500 to >300,000 MWh/Yr.

In effect, this gives a map of where in Kenya wind power development is likely to be economically viable, assuming additional transmission lines are built as planned.

[19] Land use discount factor = A factor to discount the potential area that is likely to be developed in reality, given topographical constraints at resolutions greater than that used in the IRENA analysis, and other socio-economic or cultural considerations.

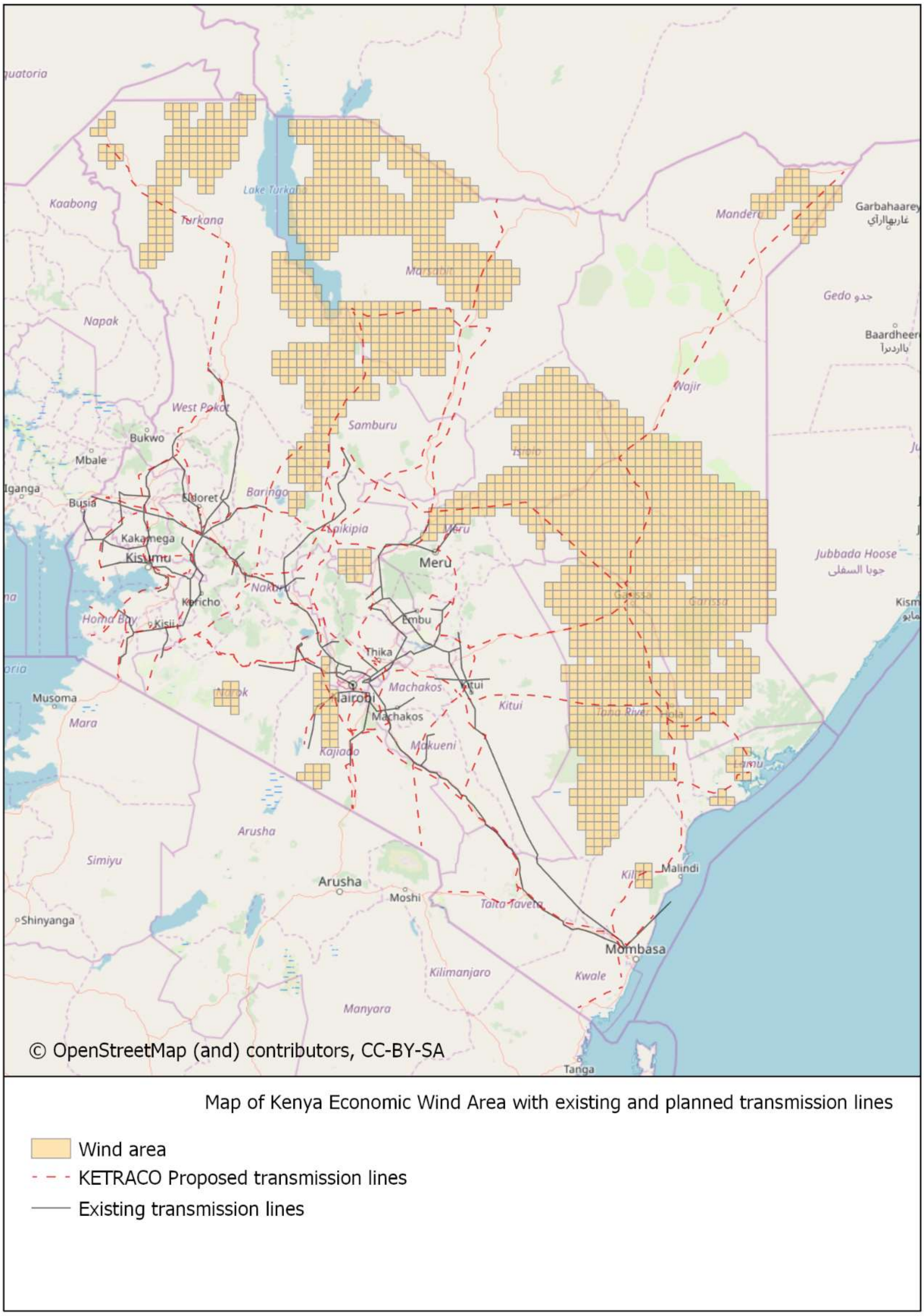


Figure 7-7. Map of pentads overlapping with economic wind area in Kenya, defined by IRENA's multicriteria analysis

7.3.2.5 COUNTY-LEVEL WIND POWER POTENTIAL

Kenya's 47 counties vary greatly in their wind power potential, as assessed by wind power models and multi-criteria analysis. Mean county-level wind energy density at 100 m ranges from 18 W/m² in Vihiga to 427 W/m² in Marsabit (

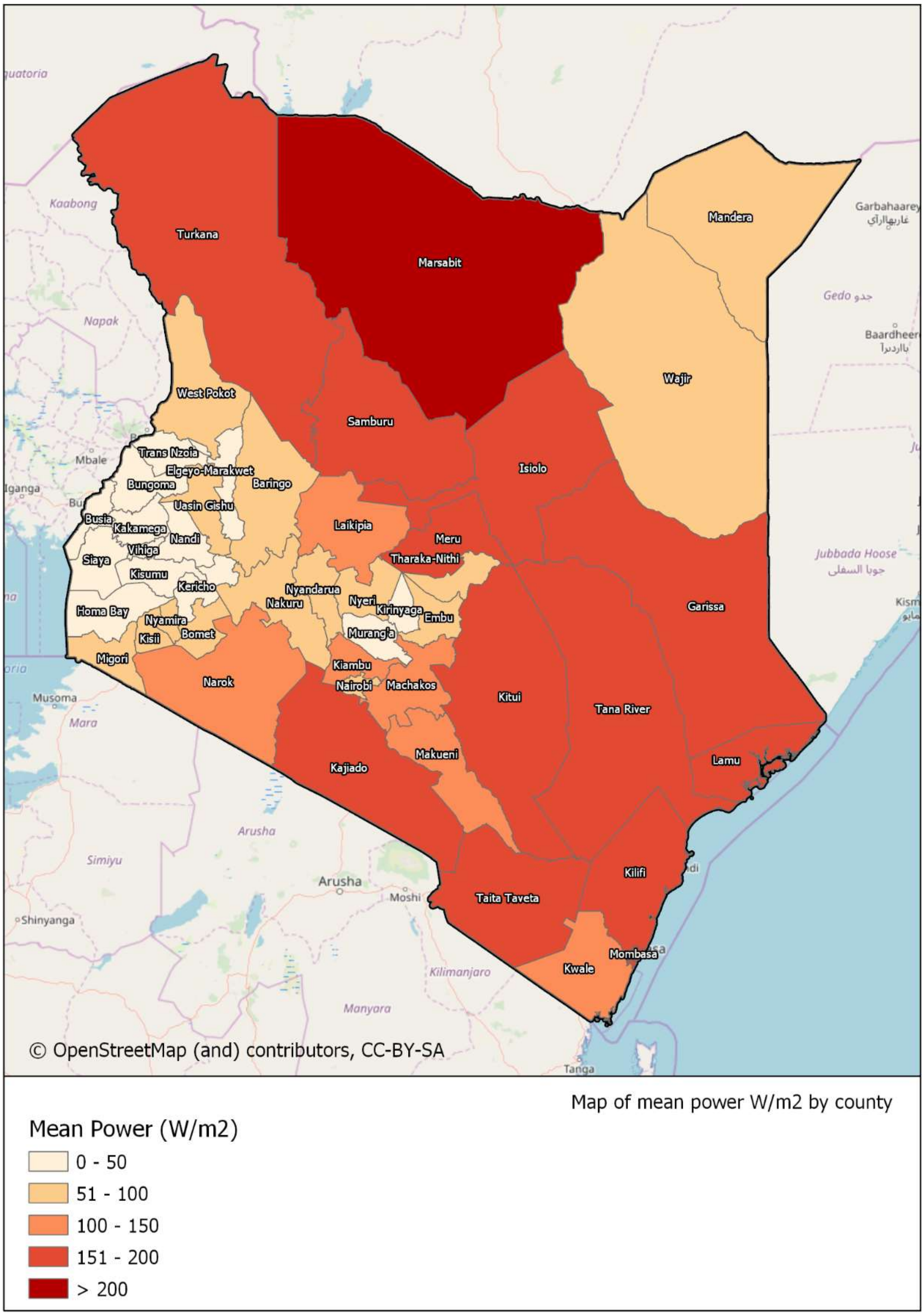


Figure 7-9: Global Wind Atlas data). Even within a county, wind energy density can vary substantially, so the maximum wind energy density may be a more useful indication of wind power potential. This ranges from 86 W/m²

in Busia to 7382 W/m² in Marsabit (

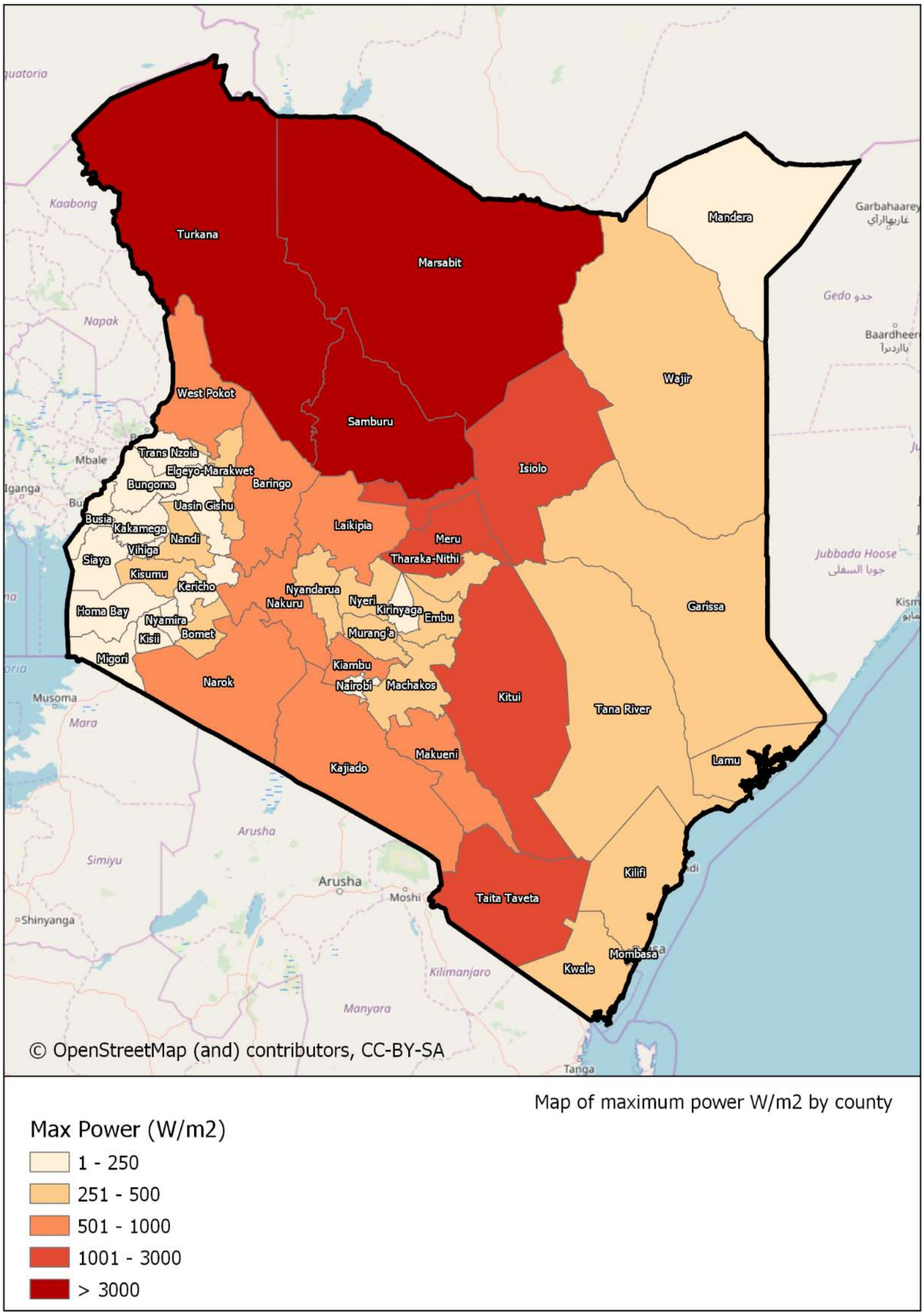


Figure 7-10: Global Wind Atlas data). However, most counties (38) have maximum wind energy density about 250 W/m², and 27 have maxima above 400 W/m². Considering IRENA's multicriteria analysis, 27 counties contain no pentads with economic wind potential. The remaining counties have between 1 (Nyandarua) and 445 (Garissa) pentads with economic wind.

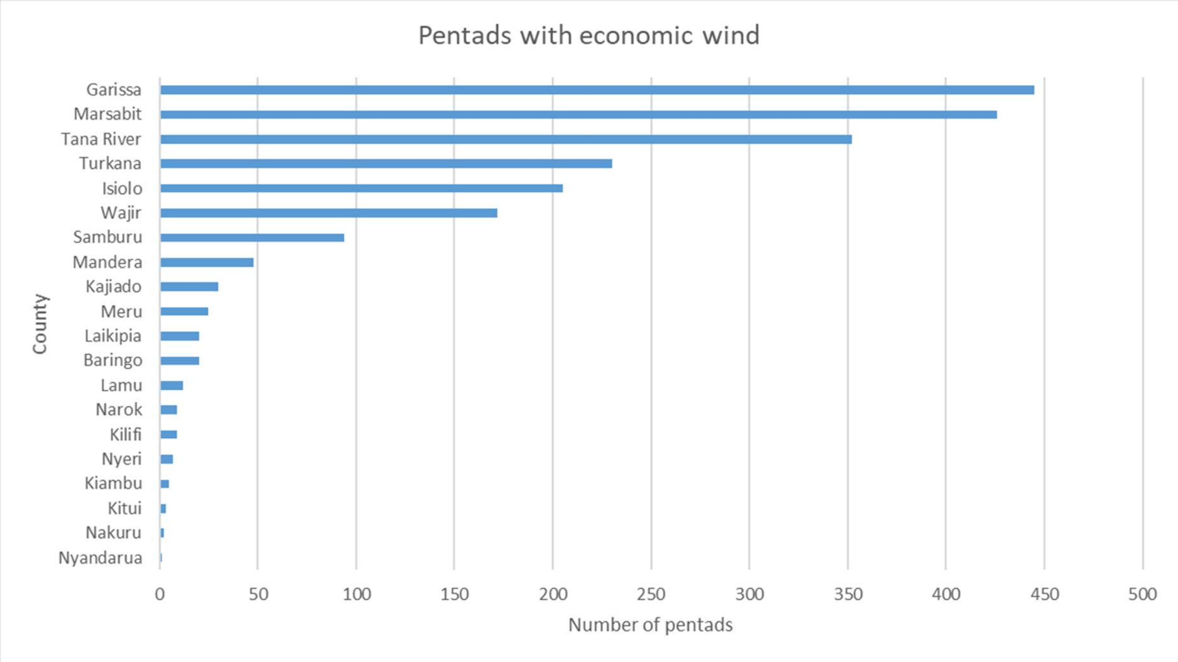


Figure 7-8. The number of pentads with economic wind resource by county, based on IRENA's multicriteria analysis

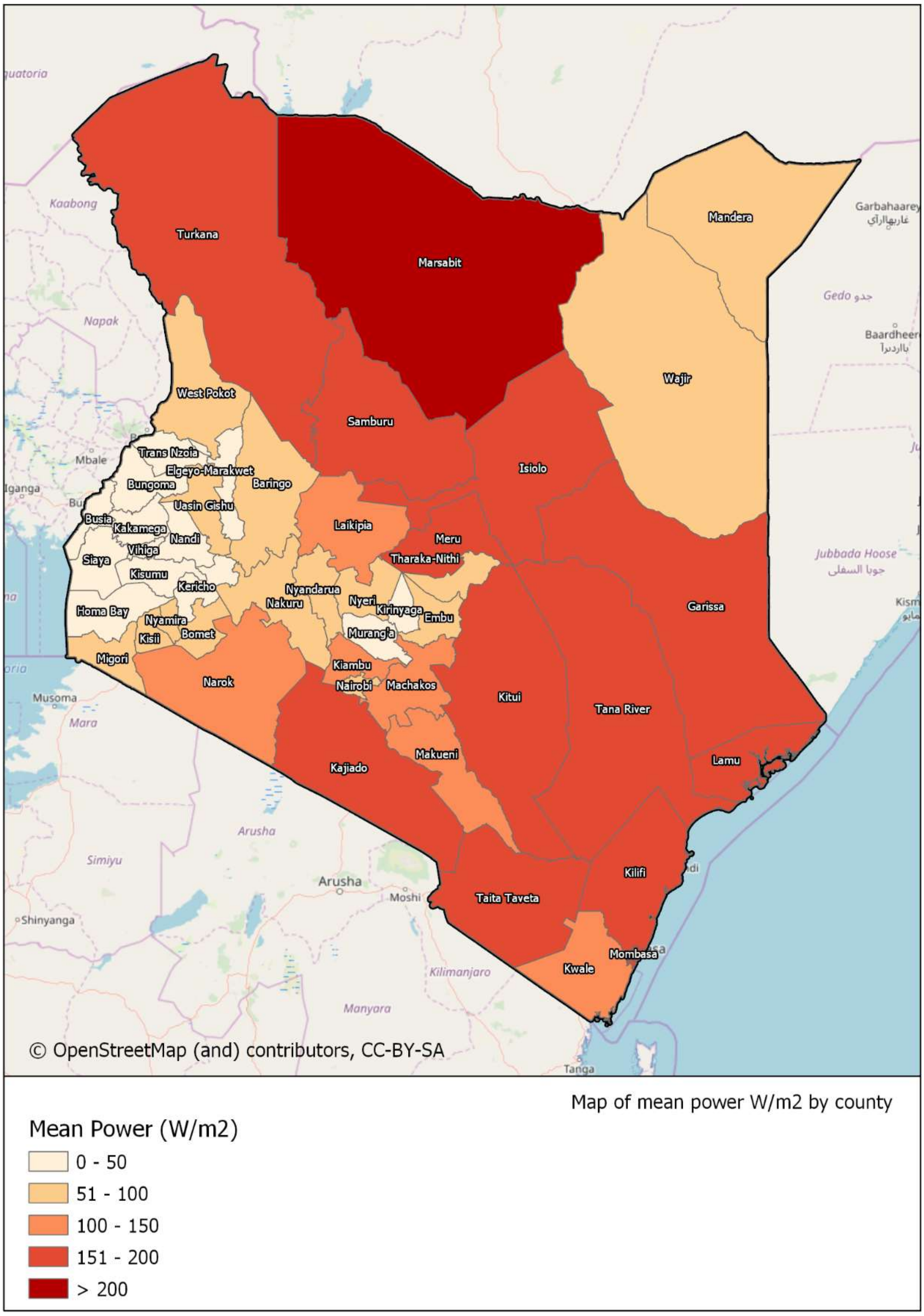


Figure 7-9. Map of mean wind power density at 100 m (W/m^2) in Kenya, by county (data from Global Wind Atlas 2.0; see Figure 7-6 for attribution)

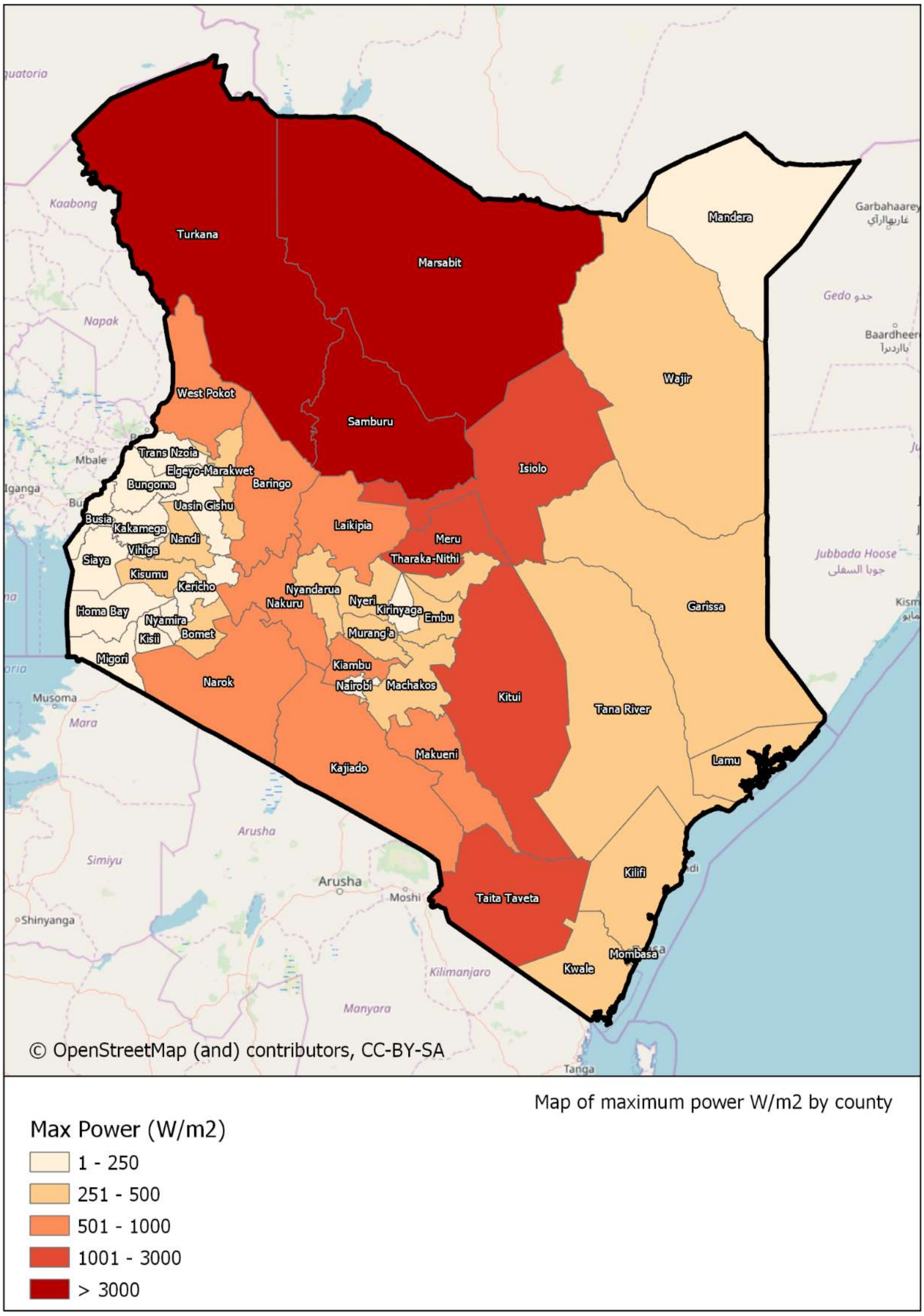


Figure 7-10. Map of maximum wind power density at 100 m (W/m^2) in Kenya, by county (data from Global Wind Atlas 2.0; see Figure 7-6 for attribution)

7.3.3 PESTEL ANALYSIS FOR WIND ENERGY IN KENYA

From the Kenya power generation master plan, the following PESTEL analysis was conducted for the wind energy sector (KPGTMP 2015):

- **Political force**: Being a domestic renewable energy source, wind power projects are given a high profile in Kenya by both the government and private sector. Due to their positive contribution to the country's sustainable socio-economic development, wind power is well accepted by international donors as well. For instance, the large-scale Lake Turkana Wind Project (LTWP) is considered a high priority project, endorsed by the Kenyan government and international donors, including major development banks. It is expected that the LTWP will pave the way for other wind power projects in Kenya.
- **Economic force**: Due to the ongoing market consolidation, the specific investment costs for Wind Turbine Generators (WTG) are decreasing, but initial investment (CapEx) and operating costs remain comparatively high. Furthermore, stand-by capacity for power system support is required due to the intermittent power output of WTGs. These capacity costs must be considered appropriately in the overall power system development. In addition, the costs for connecting remotely located wind farm sites to the national grid can be significant. For LTWP for example, a 428 km long 400 kV high voltage transmission line needed to be built, which must be factored into the project's economic and financial viability.
- **Social force**: Typically, social issues arise for the local community due to noise and shadow pollution. Potential land disputes on the proposed sites including transmission lines are common and ought to be considered accordingly. For example, the violent protests that led to the suspension of the Kinangop Wind Project demonstrate the potential adverse impacts of such unresolved social issues. The engagement and acceptance of the local community are vital for successful project implementation.
- **Technical force**: Owing to the considerable technical development, WTGs are a proven technology today. Nonetheless, they require backup capacity to support the power system in case no wind resource is available. Analysis on the required infrastructure shows that the transmission lines must be implemented before commissioning of the wind power projects, which can be complex and time-consuming due to the remote locations of many of the potential sites. For large-scale wind power ventures, the requirement of backup capacity is significant. Due to the intermittent electricity production pattern, blackouts may happen in case of any failure at wind farms
- **Environmental force**: Electricity generation based on wind energy does not emit harmful greenhouse gases and is thus seen as important for climate change mitigation. However, there are still important potential impacts on biodiversity, both at the sites for flying species, as well as due to habitat loss and/or fragmentation when constructing transmission lines
- **Legal force**: For WTG procurement, no difficulties are expected in Kenya due to political goodwill, and since there is strong international competition in the wind power industry. Established original equipment manufacturers and contractors are available to implement large-scale wind parks. Because of wind power projects' positive contribution to a country's socio-economic development, financing by international development banks remains common.

7.3.4 TECHNOLOGICAL STATUS, ADVANCES AND CHALLENGES

Though there are several types of wind turbines generators, the horizontal axis three bladed turbine has become the most common configuration. Modern wind turbines vary in size with two market ranges (KPGTMP 2015):

- Small units rated from a few hundred watts up to 50-80 kW in capacity, used mainly for rural and stand-alone systems; and
- Large units, from 150 kW up to 7 MW in capacity, used for large-scale, grid-connected systems.

The commercial proven utility-scale wind turbines usually range from 1.5 MW up to 3.5 MW for onshore applications. Grid-connected wind turbines already have a considerable impact in developed countries and are increasing in some developing countries as well. Because wind turbines do not produce power constantly nor always at their rated power (which is only achieved at high wind speeds), capacity factors are typically between 20-55% (KPGTMP 2015). One of the principal areas of concerns of wind energy is this variable power output, accommodation of which can be a challenge for the power network as the share of intermittent generation on the grid rises.

Lastly, the utilisation of the wind energy potential in Kenya might have significant impacts on the operation of the power system in future. Depending on the generation characteristics of wind plants, additional reserve capacity might be required to safeguard the adequate operation of the power system. This could lead to substantial excess cost (KPGTMP 2015).

7.3.5 KEY CHALLENGES FOR WIND ENERGY DEVELOPMENT IN KENYA

Despite the remarkable potential for wind energy expansion in Kenya, several challenges remain (Table 7-3). Several preconditions need to be met for system-friendly and least-cost integration of grid-connected wind energy (GIZ 2015). Site selection was considered a major barrier to exploitation of wind energy in Kenya (UNDP 2005). Wind potential assessments are site specific and time consuming, which means that wind energy developments require a large initial investment for careful wind prospecting. The MoE has made good progress in this area by updating the wind resource map for Kenya (WinDForce 2013) and installation of masts at 100 m. There is now relatively reliable information in the public domain to determine whether a site is viable, and developers can get additional site-specific data from the MoE.

In addition to the Feed-in Tariff vs Energy Auctions debate (see section 8.3.1.2), more also needs to be done to establish a long-term plan for wind deployment in the Kenyan energy sector. This includes cost-benefit analyses on when, where, and to what extent wind projects should be expanded and integrated into the grid, vis-à-vis the projected power generation mix comprising geothermal, hydro, solar, coal and nuclear (SWERA 2008). The LCPDP and KPGTMP are important steps towards organising the energy sector in Kenya. Other requirements are favourable financing conditions and long-term policy stability to attract private sector investment (GIZ 2015).

Many of these areas with high wind potential have relatively low human population densities, reducing the likely costs and local social impacts of development. On the other hand, grid connection and power distribution need to be considered alongside power production. High potential areas for wind tend to be far from the nearest transmission lines and electricity demand centres. Security in reaching these areas can be of concern, and major capital investments in roads and transmission lines are needed to connect these presently remote lands to the network (GIZ 2015)

Land acquisition can be challenging for both wind farms and transmission line routes, and this remains a practical obstacle to wind power development. The supply of auxiliary equipment and related services, and the availability of technical know-how remain limited (GIZ 2015).

Besides policy support in form of the Feed-in Tariff system and zero-rated import duty and removed Value Added Tax (VAT) on renewable energy equipment and accessories, the diverse financial and advisory support provided by various investors, investment banks and donor agencies has contributed to creating an enabling environment for the development of large-scale wind power projects in Kenya. Government support for large-scale wind (and solar) power is part of a broader objective to attract foreign investment in Kenya by offering the possibility of including private, independent power producers (IPP) in the energy sector (SE4All, 2016). With the increasing domestic demand for electricity and the continued decreasing costs of wind turbines globally, the development of wind power projects has become an attractive option for the government to expand generation capacity in a cost-efficient manner. There has been no shortage of ambitious goals and targets for the development of large-scale wind power projects in Kenya in successive national policies and plans.

However, according to Eberhard et al. (2016), political statements promoting the development of wind power projects in Kenya have not been followed up by adoption of a more concrete enabling regulatory framework. This gap is exemplified by the lengthy approval and PPA negotiation processes, plus associated high transaction costs. Being large infrastructure projects, they are also typically highly political in nature and involve negotiations at various levels across a multitude of actors with competing interests. Opposition to some projects from local communities and interest groups is also a key barrier for project developers (Eberhard et al. 2016). This could pose a challenge for most prospective developers to secure the sizeable capital investments needed from foreign investors. Finally, the inadequate ability of the existing grid and its management to absorb and handle the incorporation of wind power into the system constitutes a significant challenge for wind power development (AHK, 2013).

Table 7-3: Drivers and barriers for the development of large-scale, grid-connected wind power projects (adapted with some additions from Hansen 2017)

	Drivers (enabling conditions)	Barriers (dis-enabling conditions)
Knowledge and technologies	• Alignment between demand for large-scale wind power projects and competences and strategic orientation of global wind turbine firms • Decreasing costs of wind turbines globally • Good wind resources in several locations	• The inclusion of wind power into the existing grid is problematic • Limited information on location of sensitive areas for biodiversity with respect to high wind potential areas
Actors and networks	• Involvement of foreign expertise in the design, construction and management of large-scale wind power projects • Involvement of globally-leading wind turbine suppliers (providing well-proven technological concepts)	• Local communities and interest groups opposing the development of wind power projects
Institutions	• Financial and advisory support from international donors and development banks • Feed-in tariffs for wind power projects • Increasing demand for electricity driving need for expanding the generating capacity • Demand for cleaner energy	• Lengthy approval processes • Difficulties in securing funding from foreign investors and reaching financial closure due to risks • Lack of a comprehensive plan and detailed regulatory framework.

7.4 WIND SECTOR POLICIES AND PLANS

7.4.1 OVERVIEW

The Constitution of Kenya 2010 is hailed as a ‘Green’ Constitution: the right to a clean and healthy environment is enshrined in the Bill of Rights. The Ministry of Energy has the overall mandate in respect to policy formulation and implementation of energy efficiency and conservation. The Energy Act 2006 provided for the establishment of the Energy Regulatory Commission (ERC) and the Rural Electrification Authority (REA), and split Kenya Power Lighting Company (KPLC) into two entities, resulting in the establishment of

KETRACO as a transmission company, with KPLC carrying out distribution. The Environmental Management and Co-ordination Act (Cap. 387) (EMCA, 2018) is the umbrella legal framework in respect of environmental management in Kenya. Its implementing agency is the National Environmental Management Authority (NEMA).

The Government of Kenya undertakes medium to long term planning of the energy sector through the 20-year rolling Least Cost Power Development Plan (LCPDP) The last published one was the 2011-2031 Plan, with a draft 2017-2037 plan in review. The LCPDP is meant to identify existing potential in generation, and possible investments in transmission, as well as carefully forecasting on future demand for power and how best it can be met at least cost. In addition, in 2013, the then Ministry of Energy and Petroleum (MOEP) commissioned the development of a Power Generation and Transmission Master Plan (PGTMP) for Kenya, which produced the Medium- and Long-Term Plans for the periods 2015-2020 and 2015-2035, respectively. These plans entailed an identification and analysis of suitable expansion paths of the Kenyan power system for these periods.

Overall, the governance framework for the wind energy sector is relatively well mainstreamed for environmental sustainability, with most environmental obligations in national policies considered under energy sector plans and policies. Still, practical challenges remain in relation to high transaction costs and lengthy approval processes (see Section 7.3.5).

This is a Plan-level Strategic Environmental Assessment (SEA), primarily aligned to the wind power-related elements of the Least Cost Power Development Plan (LCPDP) – 2011-2031. However, in addressing the growing need and commitment to wind power development in Kenya, the SEA goes beyond the projects under this LCPDP in order to incorporate other important plans and policies around renewable energy expansion in Kenya, such as the Kenya's Power Generation and Transmission Master Plan. It takes a national perspective in order to respond to wind energy plans outlined in other important national policies and legislation around renewable energy expansion. The SEA specifically targets wind power and biodiversity, with a focus on flying species (birds and bats) as these have been shown to be most at-risk from wind power development, especially associated with turbines.

Based on the 2011-2031, draft 2017-2037 LCPDPs and MoE data, the total installed capacity for Kenya grew from 1,533 MW in 2010 to 2,213 MW in 2015, to 2,712 MW in 2018, made up of Hydro 826 MW (30.5%), Geothermal 663 MW (24.5%), Thermal (MSD) 748 MW (27.6%), Thermal (GT) 60 MW (2.2%), Wind 337 MW (12.4%), Biomass 28 MW (1%), and Solar 51 MW (2%). According to the long-term Master Plan, Kenya's objective is to increase the country's installed capacity to 6,840 MW by 2030, then to 9,521 MW by 2035. The peak load is expected to grow during the same period, from 1,570 MW in 2015 to 4,732 and 6,683 MW by 2030 and 2035, respectively. Wind power contribution is expected to rise from 26 MW (1.2%) in 2015 to 720 MW (10.5%) and 1,150 MW (12.1%) by 2030 and 2035, respectively.

7.4.2 OUTLOOK: LARGE-SCALE GRID-CONNECTED

Significant potential for wind power development exists in Kenya, with wind resource assessments indicating a total technical potential of 4,600 MW (WinDForce 2013). According to the Ministry of Energy, the installed capacity of grid-connected wind energy at the end of 2018 was 337 MW, while the installed capacity of wind hybrids in off-grid stations is estimated at about 0.55 MW. The existing wind power plants include the Ngong Hills KenGen projects that were developed and commissioned in three stages: Ngong 1, Phase I: 5 MW; Ngong 1, Phase 2: 6.8 MW; and Ngong 2: 13.6 MW. The 310 MW Lake Turkana Wind Power project has recently come on stream. Close to 20 additional wind projects, totalling around 900 MW of additional capacity, are currently in development. These projects, along with potential projects identified in the WinDForce (2013) prospectus, are shown in Figure 7-11 together with existing and planned transmission lines, overlaid on pentads with economic wind according to IRENA's multicriteria analysis (section 7.3.2.4).

Considering the earliest Commercial Operation Dates (CODs) of the projects in the LCPDP, plus projects included in the Power Generation and Transmission Master Plan (PGTMP) and other ongoing projects (Table 7-4), the wind power installed capacity was projected to reach about 1421 MW in the medium term (2028), with potential to reach close to 2,500 MW in the long term (2035) (Fig. 9 and 10). This ambitious wind development expansion model represents about 50% of the theoretical potential wind power capacity for the country. Most of this is expected to be through private investors under the Feed-in Tariff Policy or planned Energy Auctions. Already three wind Power Purchase Agreements (PPAs) have been executed with Independent Power Producers (IPPs) for development of 460 MW by 2018, with several other proposals at various stages of finalisation of PPAs, feasibility studies and/or financing arrangements.

Table 7-4: Current, planned and potential wind generation capacity in Kenya based on committed and candidate wind generation projects and their estimated Commercial Operation Dates (COD) – Sources: LCPDP 2011-2031 and draft LCPDP 2017-2037, ERC's KPGTMP 2015 and other sources

#	Source	Year	Project Name	Net capacity [MW]	Status	County
1	LCPDP	2015	Ngong 1 – Phase I & II	25	Operational	Kajiado
2	LCPDP	2018	Lake Turkana - Phase I	310	Operational	Marsabit
3	LCPDP	2020	Kipeto - Phase I & II	100	Advanced	Kajiado
4	LCPDP	2021	Aperture	50	Advanced	Kiambu
5	LCPDP	2021	Chania Green	50	Advanced	Kajiado
6	LCPDP	2021	Ngong 1 - Phase III	10	Advanced	Kajiado
7	LCPDP	2022	Electrawinds Bahari	50	Advanced	Lamu
8	LCPDP	2022	Ol-Danyat Energy	10	Advanced	Kajiado
9	LCPDP	2022	Prunus	51	Advanced	Kajiado
10	LCPDP	2022	Meru-KenGen-AfD Phase I	80	Advanced	Meru
11	LCPDP	2023	Electrawinds Bahari Phase 2	40	Advanced	Lamu
12	LCPDP	2024	Meru-KenGen-AfD Phase II	100	Early	Meru
13	LCPDP	2025	Meru-KenGen-AfD Phase III	220	Early	Meru
14	LCPDP	2026	Aeolus Kinangop	60	Paused	Nakuru
15	LCPDP	2028	Marsabit Phase I - KenGen	300	Early	Marsabit
16	Other		Bluesea-Belgut	7	Unknown	Kericho
17	Other		Bluesea-Lambwe valley	60	Unknown	Homa Bay
18	Other		Bluesea-Meru	40	Unknown	Meru
19	Other		Esidai-Frontier Market Energy	50	Mid-stage	Kajiado
21	Other		Gulf Energy	100	Unknown	Meru
22	Other		Ignite Global-Kalacha	50	Unknown	Marsabit
23	Other		WindLab Meru	80	Early	Meru
24	Other		Mombasa Cement-Vipingo	36	Unknown	Kilifi
25	WindForce		Baragoi	Not specified	Potential only	Samburu
27	WindForce		Habasweni	Not specified	Potential only	Wajir
28	WindForce		Hola	Not specified	Potential only	Tana River

29	WindForce		Laisamis	Not specified	Potential only	Marsabit
30	WindForce		Narok	Not specified	Potential only	Narok
31	WindForce		Maikona	Not specified	Potential only	Marsabit
32	WindForce		Ngomeni	Not specified	Potential only	Kilifi
34	ERC		Lamu	90	Unknown	Lamu
35	ERC		Suguroi	2	Unknown	Laikipia
36	ERC		Ndaragua	2	Unknown	Laikipia
37	ERC		Kapchebet Tea Factory	2	Unknown	Kericho
38	ERC		Olchoro Onyore	26	Unknown	Kajiado
39	ERC		Mambrui	100	Unknown	Kilifi
40	ERC		Rieny Hills	20	Unknown	Homa Bay
41	ERC		Sergoit	40	Unknown	Uasin Gishu
42	ERC		Oloitokitok	50	Unknown	Kajiado
43	ERC		Garissa	100	Unknown	Garissa
44	ERC		Mpeketoni	90	Unknown	Lamu
45	ERC		Michimikuru	30	Unknown	Meru
46	ERC		Taru Ranch	100	Unknown	Kwale
47	ERC		Tana River	50	Unknown	Tana River

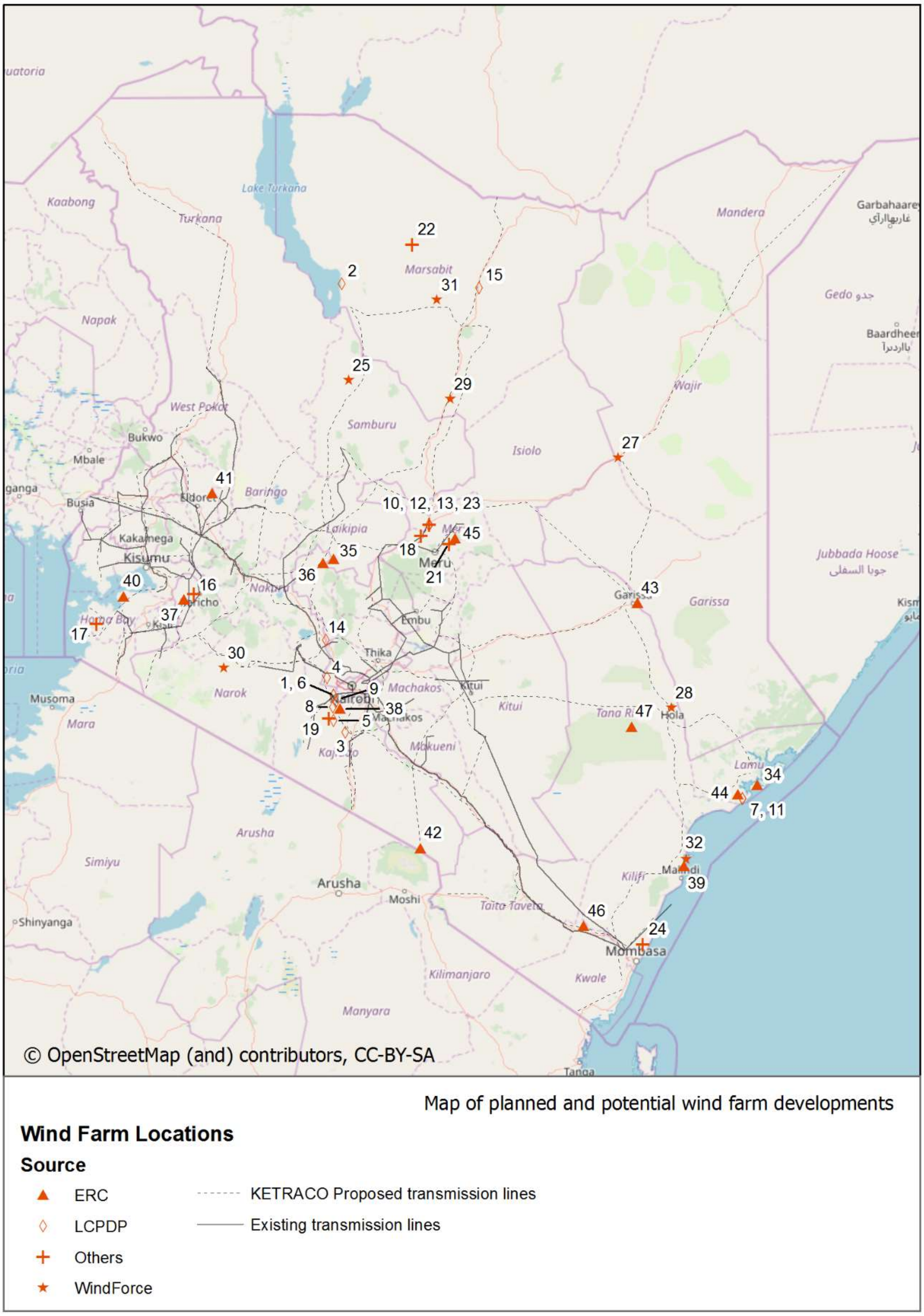


Figure 7-11: Current, planned and potential wind generation projects in Kenya, and existing and proposed transmission lines. Numbers and sources as in Table 7-4.

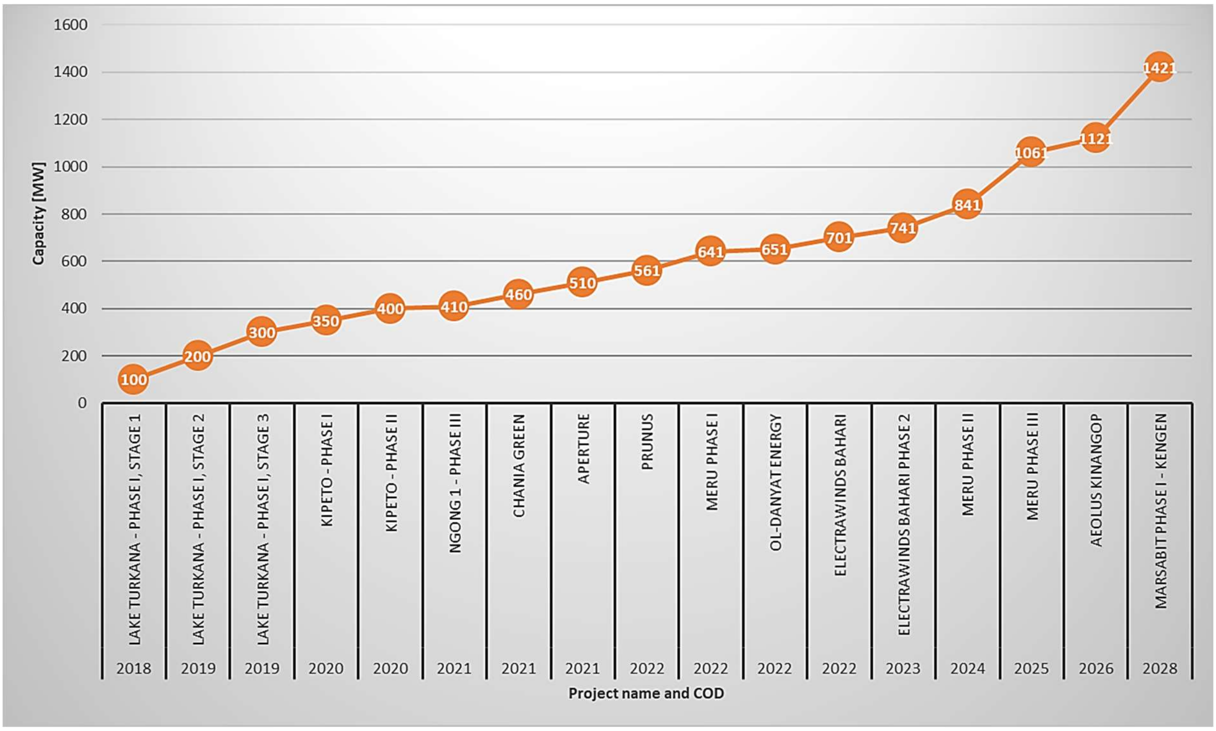


Figure 7-12: Proposed wind power projects to come online based on draft LCPDP 2017-2037

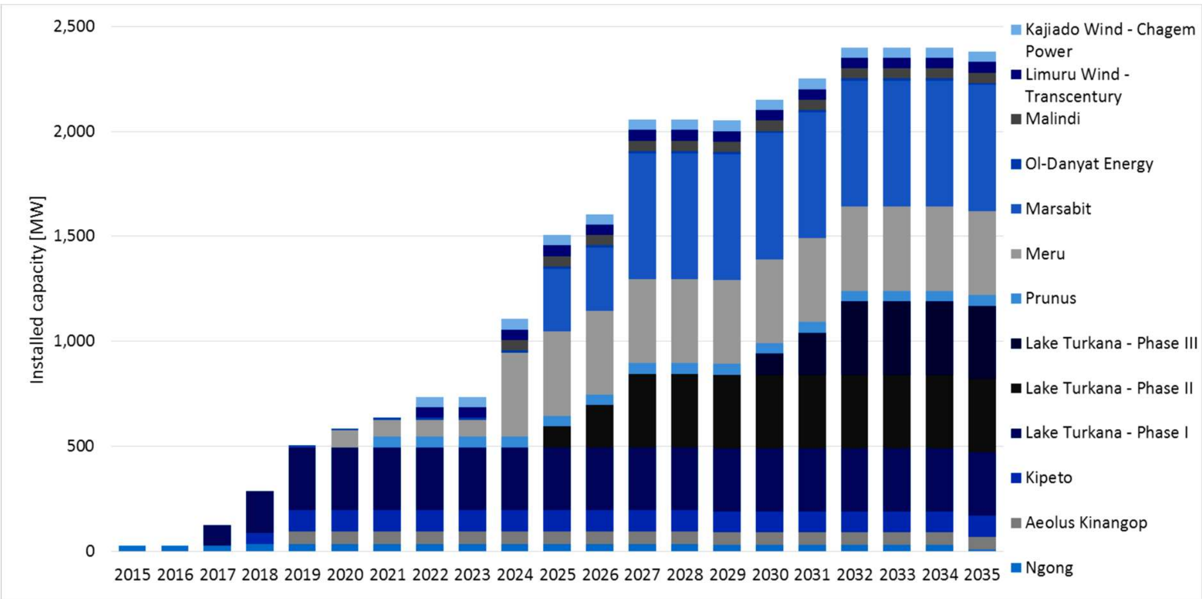


Figure 7-13: Potential wind capacity development in Kenya in the long term based on the KPGTMP 2015-2035

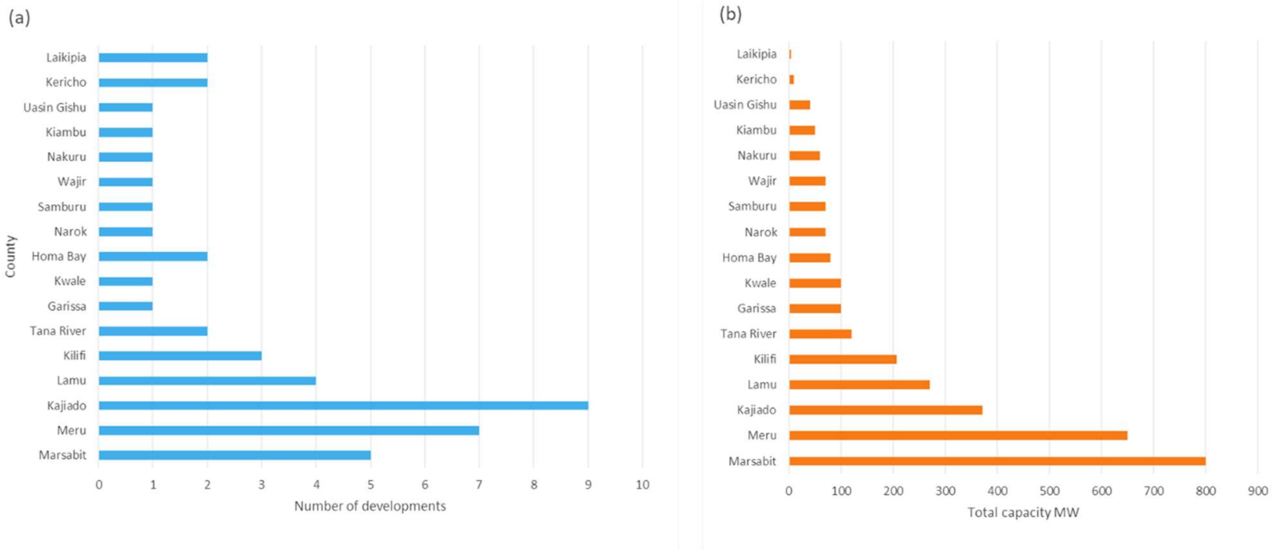

(a)
County
Laikipia
Kericho
Uasin Gishu
Kiambu
Nakuru
Wajir
Samburu
Narok
Homa Bay
Kwale
Garissa
Tana River
Kilifi
Lamu
Kajiado
Meru
Marsabit
0 1 2 3 4 5 6 7 8 9 10
Number of developments
(b)
Laikipia
Kericho
Uasin Gishu
Kiambu
Nakuru
Wajir
Samburu
Narok
Homa Bay
Kwale
Garissa
Tana River
Kilifi
Lamu
Kajiado
Meru
Marsabit
0 100 200 300 400 500 600 700 800 900
Total capacity MW

Figure 7-14. Number (a) and capacity (b) of current, planned and potential wind power developments in Kenya (see Table 7-4), by county. (Potential developments identified in the WinDForce Wind Prospectus are not associated with a capacity – for these, the mean capacity of current and planned developments (70 MW) has been used.)

For counties with current, planned and/or potential developments, the number of developments per county ranges from 1 to 9, and capacity from 4 MW in Laikipia to 800 MW in Marsabit (Figure 7-14). Most proposed or potential grid-connected wind farm developments are in relatively windy counties (

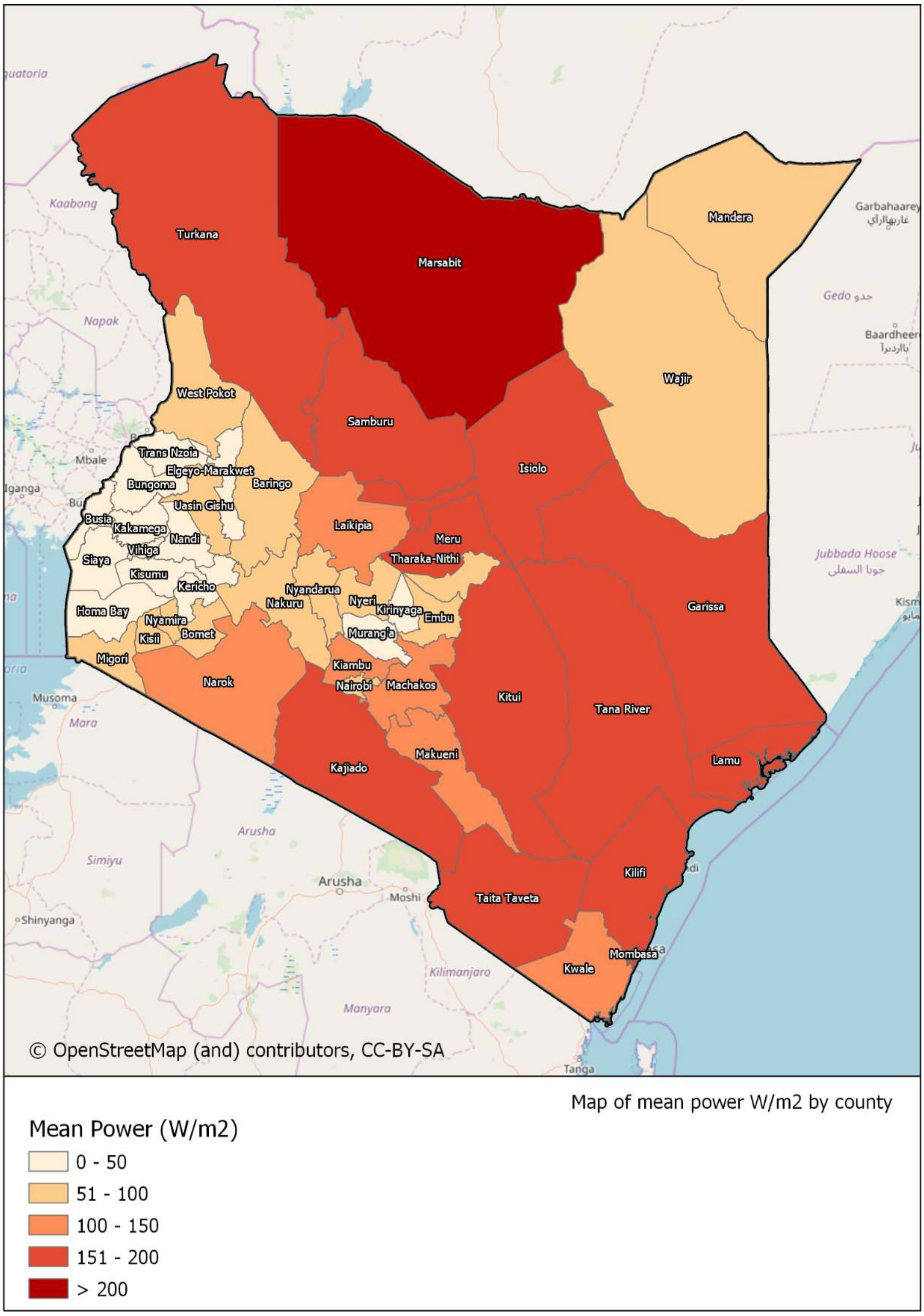
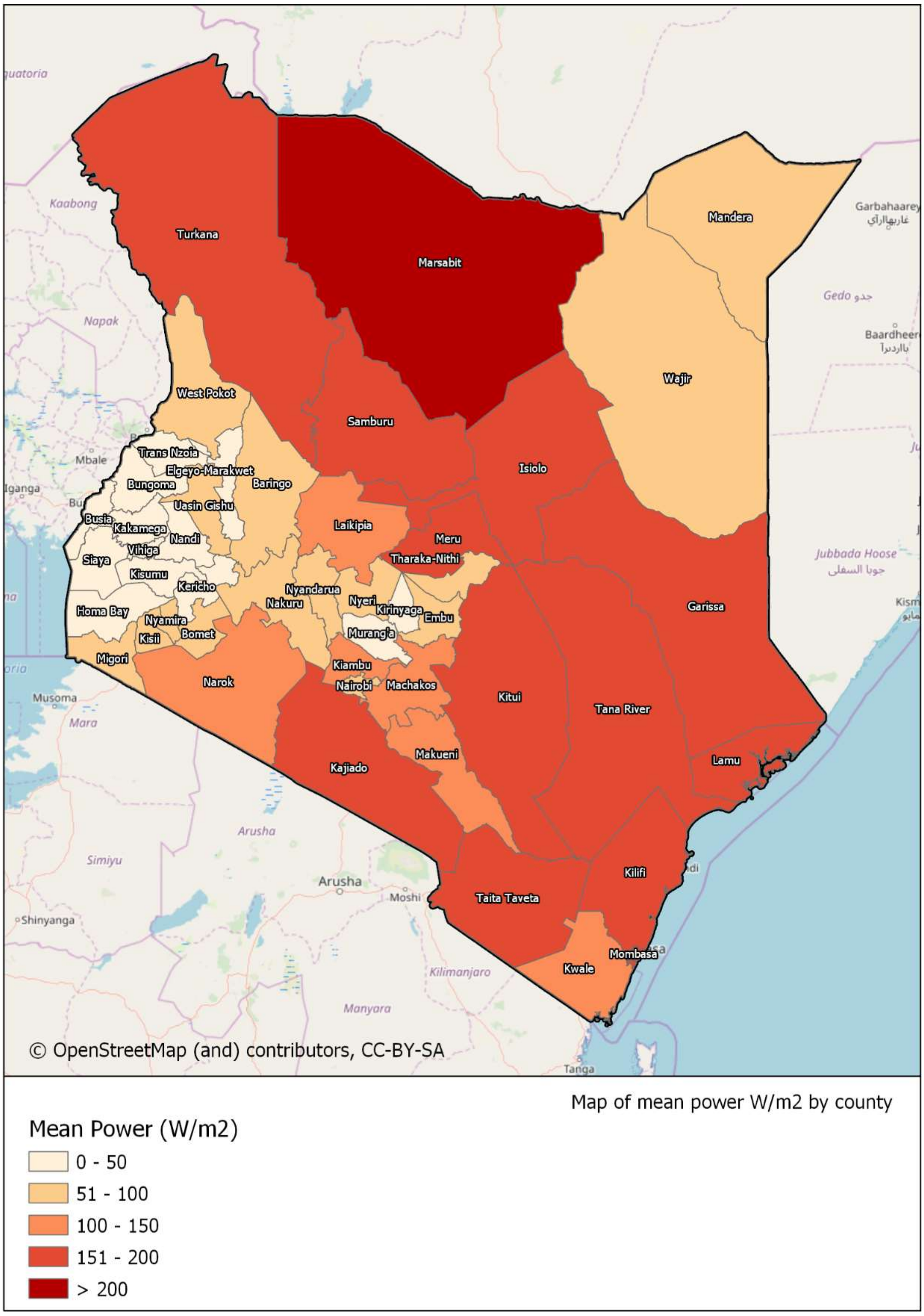


Figure 7-9


Turkana
Marsabit
Mandera
Wajir
West Pokot
Samburu
Trans Nzoia
Elgeyo-Marakwet
Bungoma
Baringo
Uasin Gishu
Busia
Kakamega
Nandi
Vihiga
Siaya
Kisumu
Laikipia
Isiolo
Meru
Tharaka-Nithi
Kericho
Nyandarua
Nakuru
Nyeri
Kirinyaga
Embu
Homa Bay
Nyamira
Kisii
Bomet
Murang'a
Garissa
Migori
Kiambu
Nairobi
Machakos
Narok
Kitui
Tana River
Makueni
Kajiado
Lamu
Kilifi
Taita Taveta
Mombasa
Kwale
© OpenStreetMap (and) contributors, CC-BY-SA
Map of mean power W/m2 by county
Mean Power (W/m2)
0 - 50
51 - 100
100 - 150
151 - 200
> 200

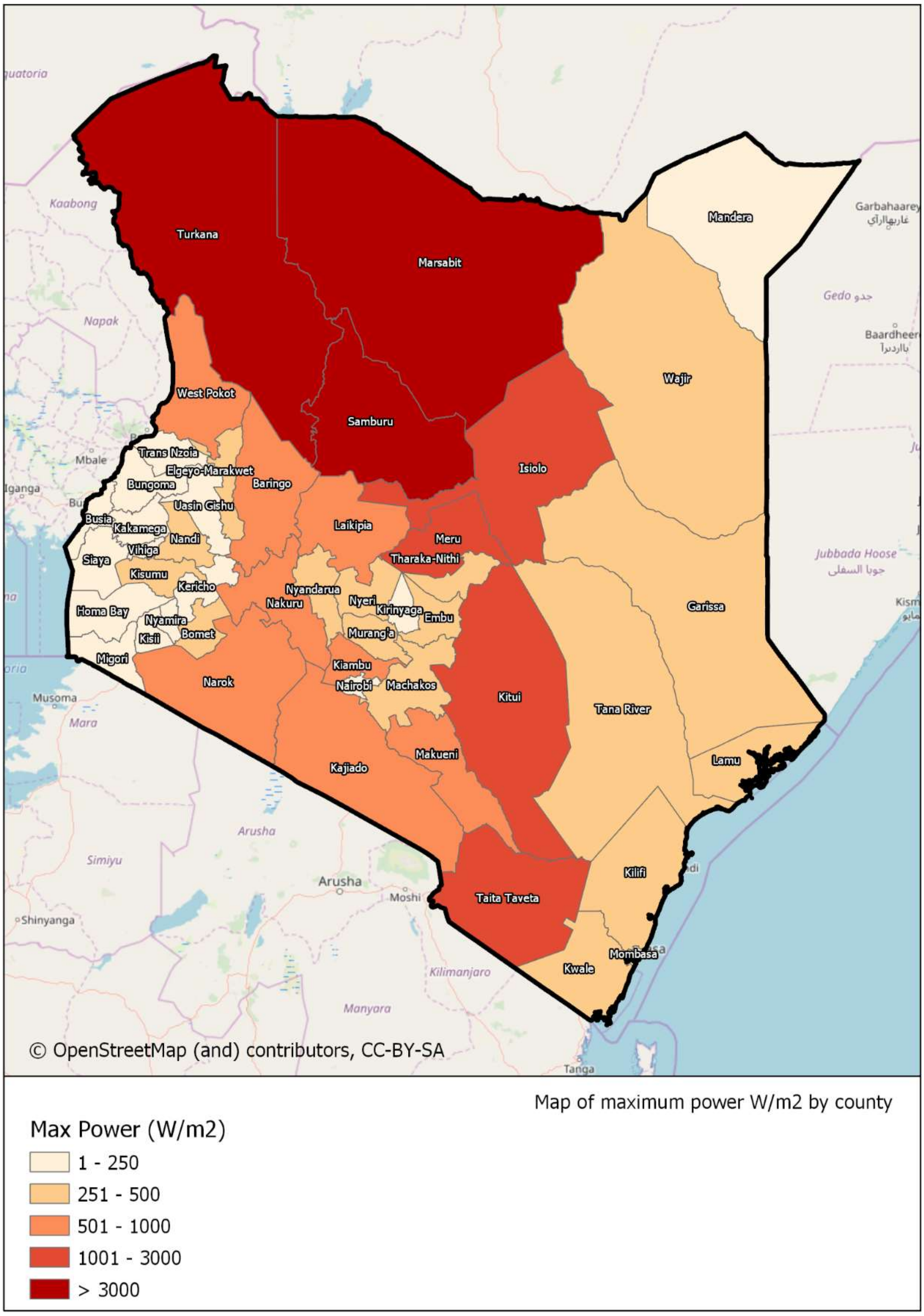


Figure 7-9

Figure 7-10), and Kajiado, Kilifi, Lamu, Meru and Marsabit counties each have more than 200 MW of wind power development in the long-term pipeline. However, some counties with high wind potential have no developments listed (e.g. Turkana, Isiolo, Kitui, Taita Taveta based on mean/maximum wind energy, and Mandera and Baringo based on number of pentads with economic wind). On the other hand, Kwale, Uasin Gishu, Homa Bay and Kericho all have wind power developments but no pentads mapped with economic wind. Wind energy density is relatively high in some parts of Kwale and Uasin Gishu (maximum values 596 and 304 W/m^2 respectively), but not in Homa Bay and Kericho (maximum values 220 and 184 W/m^2). This suggests that while wind modelling and mapping provide a useful general picture, (a) they are not necessarily accurate at local scale and/or (b) there are other important factors influencing where developments are sited.

7.4.3 OUTLOOK: WIND MINI-GRIDS IN KENYA

7.4.3.1 OVERVIEW: MINI-GRIDS IN AFRICA

According to the Africa Mini-grid Developers Association (AMDA), more than 600 million people living in Africa, largely in rural areas, do not have access to power. The dominant means of providing them power is through grid connections. For governments and donors aiming to connect rural citizens, mini-grids typically offer a more cost-effective solution than conventional grids. Mini-grids are decentralised (off-grid) systems consisting of power generation assets and distribution with power capacity between 0.2 kW and 2 MW connecting two or more individual households (Hansen 2017).

Tanzania is considered a regional leader in mini-grid development, having at least 109 mini-grids with an installed capacity of about 157.7MW, and serving about 184,000 customers (Odarno et al. 2017). Of the 109 plants, 16 are connected to the national grid while the rest operate as isolated mini-grids. Though hydro is the most common technology (49 mini-grids), 19 of these systems are fossil fuel-based, and account for 93 percent of customer connections and almost half of total installed capacity. There are 25 biomass mini-grids; and 13 solar mini-grids but no wind mini-grids in Tanzania (Odarno et al. 2017). To expand mini-grids in Africa and make them 'greener', the following recommendations have been made that Kenya can learn from (Odarno et al. 2017):

- Build up knowledge about mini-grid experiences. Understanding what makes mini-grids succeed (or fail) can be extremely helpful to countries across Sub-Saharan Africa
- Make information about mini-grids available to relevant actors. National utility regulators and other relevant authorities should boost efforts to make relevant information available to developers and project sponsors, especially on mini-grid operational performance
- Simplify the mini-grid planning process and improve coordination: The benefits of streamlined licensing and tariff-setting procedures should not be undermined by cumbersome clearance and permit processes outside of the energy sector
- Build capacity, particularly locally. Mini-grid developers need to be able to develop and submit bankable proposals and implement mini-grid projects successfully. Capacity building is also key to the success of the competitive bidding arrangements under applicable regulatory frameworks
- Understand the development impacts of mini-grids. Most of the information on the socioeconomic impacts of mini-grids in Sub-Saharan Africa remains anecdotal. More systematic qualitative and quantitative studies would help inform rural development programs and energy access strategies. Research on the impact of different business models and financing interventions would also be useful.

7.4.3.2 ELECTRICITY MINI-GRIDS IN KENYA

The Government of Kenya aims to achieve universal access to electricity by 2020 (ESMAP 2017). In 2017, 50% of the country's population was connected to the grid; extending the traditional grid is eventually expected to reach up to 90% of the population with mini grids and stand-alone systems connecting the remainder (ESMAP 2017). Presently, there twenty-seven state-owned mini-grids across the country, mostly in county and sub-county headquarters and owned by the Rural Electrification Agency (REA) and operated by the Kenya Power and Lighting Company (KPLC); two are owned and operated by the Kenya Electricity Generating

Company (KenGen)[20]. The mini-grid stations are mostly diesel-fired generators and combined hybrids with solar; only two are wind energy hybrids, one diesel-wind hybrid plant (Marsabit, 500 kW) and a solar-wind-diesel hybrid plant (Habaswein, 50 kW) (Hansen 2017; Nygaard et al. 2018).

Additionally, there are diverse private and community mini-grid developers in Kenya, including larger established companies and small entrepreneurs such as IPS Kenya, PowerGen, Powerhive, RVE.SOL, SteamaCo, Wind for Prosperity Kenya (consortium of Vestas, Frontier Investment Management and Maara Energy), Greenpower Engineering, Ofgen, KMR Infrastructure, Renewvia Energy, Skynotch Energy Africa, Renewable World, University of Southampton/Energy for Development, and UNIDO (Carbon Africa Limited 2015). They currently operate 22 private-owned and 11 community-based mini-grids in Kenya, mostly diesel and solar; none is a wind system. The private model is employed in all of them with generation and distribution assets owned by the same company. The tariff charged in all these mini-grids is reflective of cost (Nygaard et al. 2018).

Lastly, there are 26 additional mini-grid stations currently being developed by REA, all which are hybridised with solar but none with wind (Nygaard et al. 2018). Further, under the Kenya Off-Grid Solar Access Project (KOSAP), the Government plans to establish 120 mini grids under a public-private partnership (PPP) model, jointly implemented by REA and KPLC. Private companies will build the generation and distribution network, and operate and maintain those assets over seven to ten years. The mini grid customers will be charged a regulated tariff, paid to KPLC. The private companies will receive monthly payments from KPLC for services provided under the Power Purchase Agreement (PPA) (ESMAP 2017). The REA Strategic Plan has also identified 629 un-electrified trading centres, 450 of which they plan to electrify through the establishment of renewable energy mini-grids (REA 2017). During the same period (2017-2021), REA intends to install and meter stand-alone wind energy systems in at least 20 institutions across the country (REA 2017).

Overall, a recent review revealed that the small wind turbine sector in Kenya was growing but is characterised by one-time experiments, fragmented learning experiences, lack of focus and low-quality products and services (Kamp and Vanheule 2015). The main barriers identified for mini-grid development in Kenya include (Fraatz et al. 2016):

- **Regulatory framework and policy**: deficiencies in policy and regulatory framework for mini-grid market development including timelines for main grid expansion not known, and lack of clarity around tariff setting (e.g., cost-reflective vs. national tariff)
- **Access to finance**: few investors are willing to take the risk associated with these small projects, leaving a high dependency for donor and grant funds to demonstrate bankable business models
- **Technical capacity**: technical skills are still insufficient along the mini-grid value chain of planning, design, construction, operations, maintenance and management, besides the high operational costs due to most being in remote, hard-to-access areas
- **Business models**: most mini-grids end up with high electricity cost due to high investment costs, yet are typically faced with a low ability to pay in the remote areas where most operate. Major business models – mini-grid concessions or IPPs – remain largely untested in Kenya.

[20] The mini-grid customers enjoy similar tariffs as the rest of the country, made possible through cross-subsidies such that the generating and operating costs of these projects are spread across all Kenya Power customers, thereby shielding the customers from paying the true cost of power.

7.4.3.3 EXISTING AND POTENTIAL WIND MINI-GRIDS IN KENYA

Small-scale wind in Kenya started in the 1980s with pilot feasibility projects, seeing little development until the late 1990s when small-scale wind turbines became cheaper and more common. This enabled considerable experimentation and learning within the sector. Nevertheless, while the use of large-scale wind energy in Kenya is gathering pace, the use of small-scale wind has thus far been rather limited in terms of electrification; using small-scale wind for water pumping is more common (Nygaard et al. 2018). Only two of the existing mini-grids have wind energy: one diesel-wind hybrid plant in Marsabit (500 kW) and one solar-wind-diesel hybrid plant at Habaswein (50 kW). The total installed capacity of wind power in these mini-grids are 0.55 MW (ERC, 2015). There are plans to increase the wind-diesel hybrids mini-grid systems from the current 0.55 MW to 10 MW (Hansen 2017).

Beside these publicly-owned mini-grids, there are also the private companies that offer wind and solar-powered mini-grids to off-grid villages and households on a commercial basis. However, it was not possible to confirm the exact number of private wind-powered mini-grids in operation in Kenya as plant specific information is scarce (see also Hansen 2017). Still, it appears likely that almost all the existing private mini-grids are either solar-diesel hybrids or solar-powered. According to Hansen (2017) previous domestic wind turbine suppliers like PowerGen and SteamaCo have increasingly shifted their focus and activities toward the emerging market for solar-powered mini-grids. This has been attributed to the limited size of the domestic market for wind turbines compared to the emerging market for solar PV due to their price and relative ease of installation (AHK 2013; Tigabu 2016). Today, multiple companies offer imported wind turbines, but they are predominantly installers of solar PV systems who complement their portfolios with wind turbines (Kamp and Vanheule 2015).

There are currently several wind-powered mini-grids at various stages of development, from the initial planning and feasibility stage to the final construction and operational stage. The UNIDO-funded project in Ngong hills implemented in 2009 involved a solar-wind-diesel hybrid mini-grid with a total installed capacity of 10 kW (including a 3-kW wind turbine) (Nygaard 2018). AHK (2013) lists five new wind-diesel hybrid mini-grids currently under construction in Kenya with a total capacity of 600 kW. The Kenyan government's rural electrification master plan from 2009 also included support for the retrofitting of existing diesel-based decentralised power stations into hybrid schemes with wind and solar PV (REA, 2009). As part of the implementation of the master plan, 44 new sites are planned to be developed as hybrid mini-grids among which 19 include wind turbines with a total capacity of 1.9 MW (AHK, 2013). KenGen also plans to hybridise the Lamu plant with wind turbines, while the Agence Française de Développement (AFD) is also supporting the hybridisation of 13 of the state-owned mini-grids, albeit only one in Wajir is getting a 300kWp boost from wind power with the rest being solar (Nygaard et al. 2018).

Nygaard and colleagues (2018) assessed of the proportion of mini-grid sites in Kenya that may be suitable for the integration of small wind turbines, based on an estimate of the wind resource in the immediate area surrounding a mini-grid. The analysis is carried out within a radius of 2.5 km around each mini-grid site location. For each circle's area around a specific mini-grid location, the Global Wind Atlas data were extrapolated to a height of 20 m above ground to be more representative of the resource a small wind turbine would experience. They identified 230 mini-grids that are in operation, under construction or at an advanced planning stage. 155 of those with associated geographical coordinates (184 sites) were under 150 kW and 29 sites over 150 kW (Figure 7-15).

For those <150 kW sites, an annual average wind speed of 4 m/s[21] or above was chosen as the cut-off for whether a

[21] Annual average wind speed = the average of the top 10% annual mean wind speeds from within a 2.5 km radius circle of the mini-grid location

site was considered viable or not. This is a useful but coarse delineator because feasibility depends on a huge range of other factors, including specific wind turbine performance, exact siting, economic context, and institutional and community factors. From the data set of mini-grids available, it was estimated that approximately 53 of the 155 sites (34%) would potentially be suitable for the integration of wind power when considering the wind resource alone (Nygaard et al. 2018) (Table 7-5,

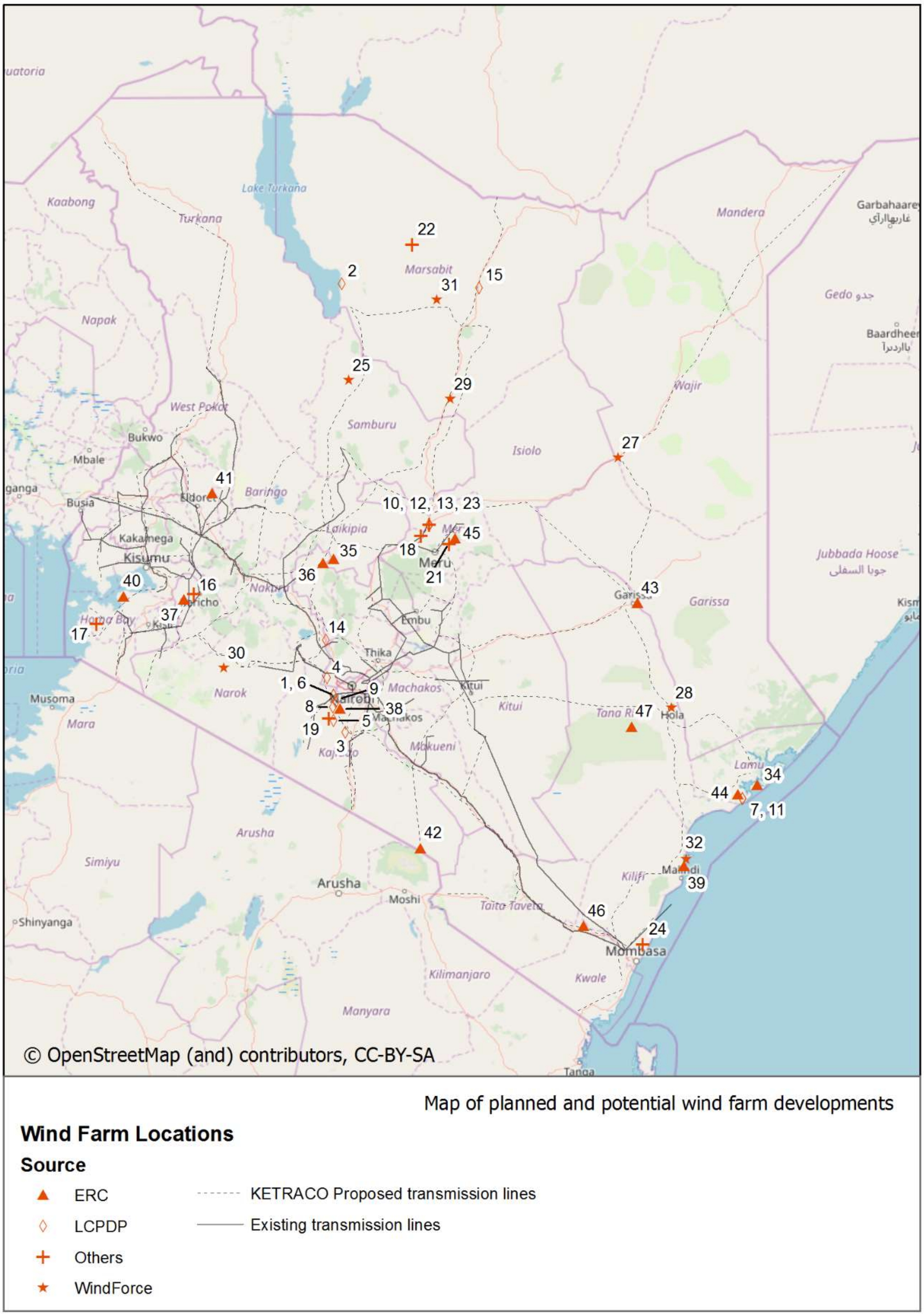


Figure 7-11).

Table 7-5: Potential for wind mini-grids in Kenya: summary of results of analysis by Nygaard et al. (2018)

Category	Number of sites	>4 m/s	Proportion

K-OSAP sites (<150kW)	89	27	32%
REA sites (<150kW)	25	8	32%
All other sites (<150kW)	41	18	44%
All sites under 150kW	155	53	34%

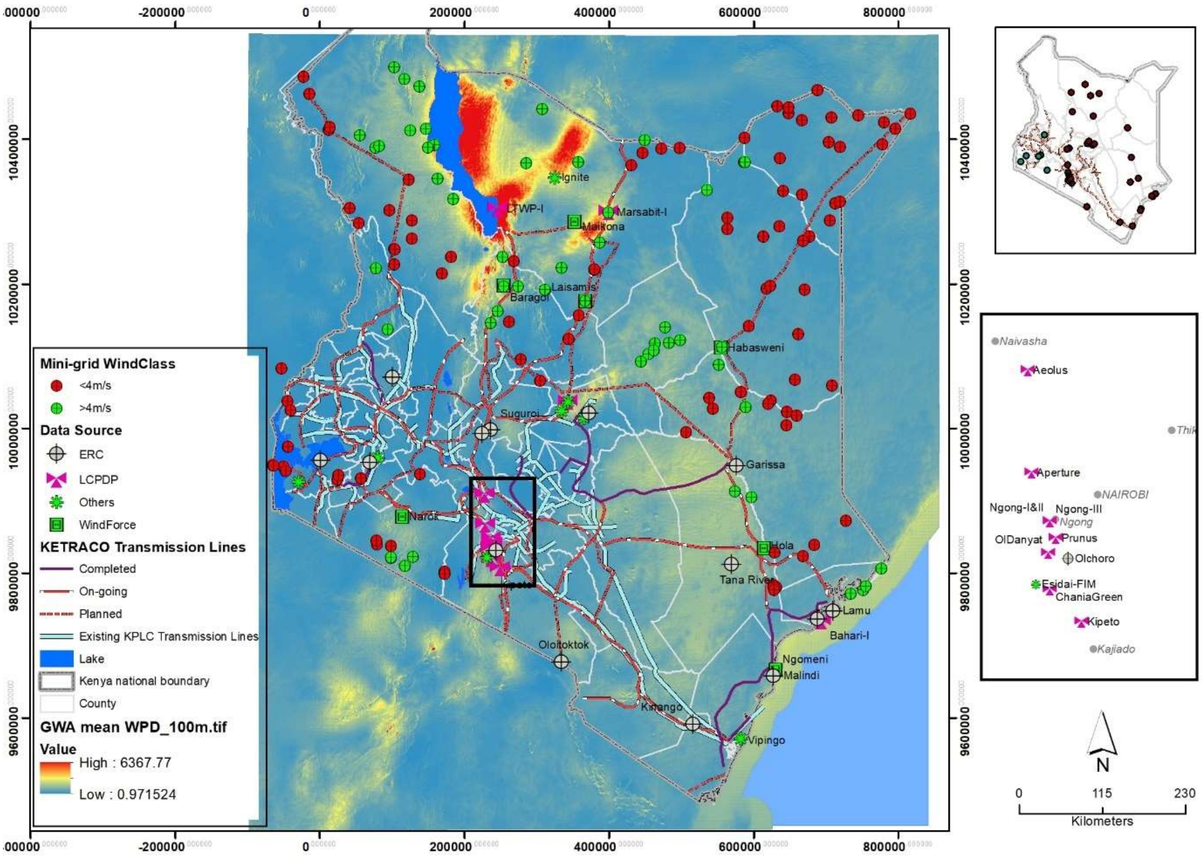


Figure 7-15: Location of all potential wind mini-grid sites (annual average wind speed ≥4 m/s) identified by Nygaard et al. (2018) alongside current, planned and potential wind sites highlighted (mini-grid data from Nygaard et al. 2018)

The lack of experimentation with wind-powered mini-grids means that only limited experience and knowledge have been accumulated within this sector (Hansen 2017; Nygaard 2018). The turbines manufactured locally typically boast a capacity between 150 W and 3 kW, with roughly 120-150 installed turbines of this range in Kenya (Vanheule 2012). However, some companies have recently started manufacturing or fabricating small scale turbines too (AHK 2013). In general, the performance of imported small-scale wind turbines, which are typically used in existing hybrid mini-grids, is generally better, but also more expensive compared to locally manufactured turbines (Vanheule 2012). Several private companies manufacture or import and market small wind turbines in Kenya, including RIWIK (a Dutch Company), WindGenEA; CraftskillsEA, Kenital solar, Davis & Shirtliff, Chloride Exide and Power Point Systems EA (AHK 2013; Tigabu 2016). The capacity of imported turbines is around 1-5 kW, and an increasing number of local manufacturers are offering these turbines from China (Kamp and Vanheule 2015).

8 GOVERNANCE FRAMEWORK

8.1 OVERVIEW

Environment and natural resources in Kenya are valuable national assets that must be sustainably managed for present and future generations. They offer a range of benefits and opportunities for local and national economic development, improved livelihoods and provision of environmental goods and services. The promulgation of The Constitution of Kenya 2010 marked an important chapter in Kenya's environmental policy development. Hailed as a 'Green' Constitution, the right to a clean and healthy environment is enshrined in the Bill of Rights.

The Ministry of Energy has the overall mandate in respect to policy formulation and implementation of energy efficiency and conservation. The energy sector is guided by the policy set out in Sessional Paper No. 4 of 2004 and governed by several statutes, principally the Energy Act, No. 12 of 2006, the Geothermal Resources Act No. 12, of 1982 and the Petroleum (Exploration and Production) Act, Cap 308. With the promulgation of the Constitution of Kenya 2010 and development of the Kenya Vision 2030, there have been many policy and legislative changes.

The Energy Act 2006 provides for the establishment of the Energy Regulatory Commission (ERC) and the Rural Electrification Authority (REA). In addition, the Act also establishes the Energy Tribunal whose purpose is to hear appeals from decisions of the ERC. The institutional setup situates the ERC and the Tribunal as overall regulatory bodies independent of State influence. The two coordinate and advise the Ministry of Energy on policy and strategy. The Act also split Kenya Power Lighting Company (KPLC) into two entities, one for transmission which will be 100% state-owned and the other for distribution which will be private sector-owned. This has seen the establishment of KETRACO as a transmission company, with KPLC carrying out distribution.

The Environmental Management and Co-ordination Act (Cap. 387) (EMCA, 2018) is the umbrella legal framework in respect to environmental management in Kenya. Its implementing agency is the National Environmental Management Authority (NEMA). It recognises a "Lead Agency" as any Government institution in which any law vests functions of control or management of any element of the environment or natural resource. Lead Agencies therefore play an important role in enforcing compliance with laws and regulations.

Environmental management in Kenya cuts across various government agencies at both national and county levels. However, NEMA is charged with overall coordination and establishment of appropriate legal and institutional frameworks for management and conservation of biological diversity.

For this SEA, we undertook both an institutional framework analysis and a detailed Policy Review, going from the overarching policy documents (e.g., Constitution, 2010) to sector-specific ones, particularly the energy and environment sectors in Kenya, as well as internationally-recognised good practice standards. Key policy and plan documents that were considered in this PPP review and analysis include, amongst others:

General

- Constitution of Kenya 2010
- Kenya Vision 2030

Energy sector

- Sessional Paper No. 4 of 2004
- Energy Act, 2006
- Energy Bill, 2017
- Feed-in Tariff Policy, 2012
- Least Cost Power Development Plan, 2011-2031 (and where appropriate, 2017-2037 Draft Plan)
- Kenya Power Generation and Transmission Master Plan, 2015-2035
- Sustainable Energy for All by 2030, Kenya Investment Prospectus

Environment sector

- The Wildlife Management and Conservation Act, No. 47 of 2013
- Community Land Act, 2016
- Climate Change Act 2016
- Various international treaties/obligations/conventions related to biodiversity including CBD and UNFCCC

International good practice standards

- World Bank Safeguards
- IFC Performance Standards.

8.2 PPP ANALYSIS

8.2.1 GOVERNANCE FRAMEWORK IN THE ENERGY, ENVIRONMENT AND BIODIVERSITY SECTORS

The governing framework for the energy sector in Kenya contains a diverse array of laws, policies and regulations (Figure 8-1). The Kenyan Government has shown support for renewable energy projects through formulation of policies and strategies to encourage uptake of renewable energy as an option in the country's energy mix. Analysis of the major policy instruments points towards government commitment and efforts to promote renewables at different scales: off-grid, mini-grids and on-grid (IREK 2018). However, IREK warns that these efforts may be insufficient if not supported by requisite capabilities at individual and institutional level. Indeed, some of the key policy documents recognise that insufficient skills and capabilities are limitations to renewable energy development (IREK 2018).

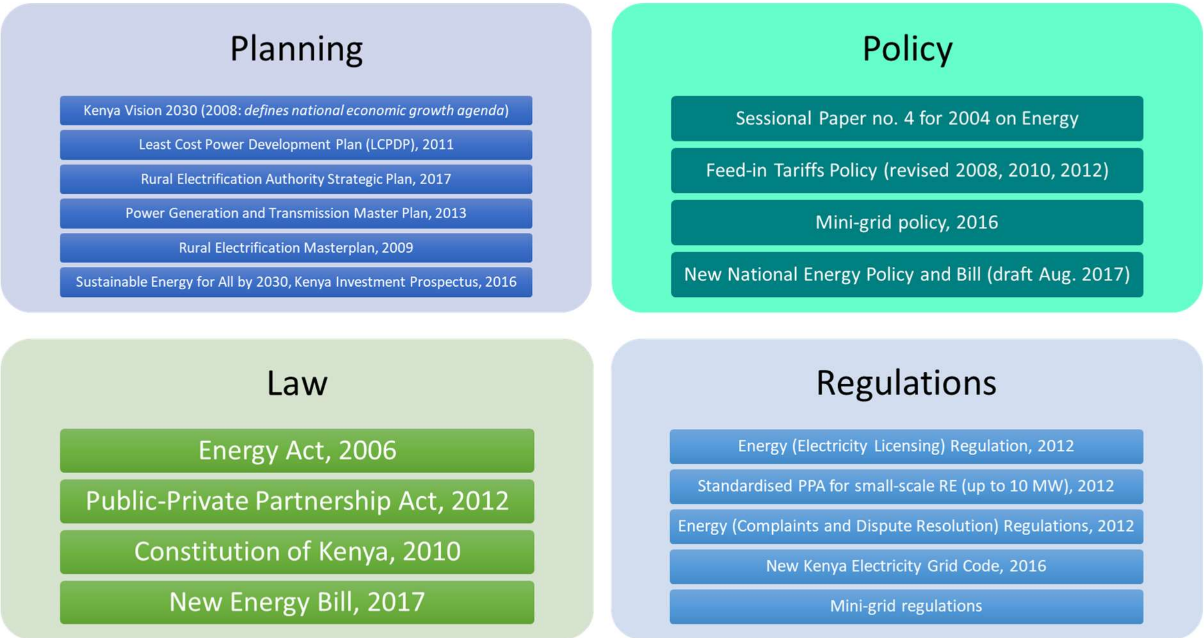


Figure 8-1: Key elements of the governing framework for the energy sector in Kenya (adapted from GIZ 2016)

8.2.1.1 NATIONAL POLICY FRAMEWORK

Framework	Objectives & Relevant Requirements	Potential interaction with the wind power & biodiversity SEA
Constitution of Kenya 2010: Natural resources	Article 69 of the Constitution addresses environment and natural resources and encourages public participation in the management, protection and conservation of the environment. It outlines the need for EIA/EA and monitoring of the environment	• Wind power infrastructure can lead to biodiversity loss through collisions, habitat alteration and degradation • Public participation in the SEA process and during the implementation of the Plan is expected
Constitution of Kenya 2010: Devolved Government	The Constitution provides for the distribution of functions between the National and County Governments. The functions of the National Government include the protection of the environment and natural resources and developing Energy policy and energy regulation. Part 2 of the 4th Schedule provides for the functions and powers of the County Governments, which also include electricity and gas reticulation and energy regulation	Since wind capacity and biodiversity are variably located in certain counties, it will be necessary to engage the respective County Governments during the SEA process and more so during implementation of the Plan
Vision 2030	Vision 2030 is based on three pillars: economic, social and political pillars. The pillars are interrelated, and natural resources and the environment are considered the fabric that binds them together by supplying of renewable and non-renewable goods and services	Development projects envisioned under the Vision 2030 will increase demand on Kenya's energy supply. Sustainable sources of energy will need to be sought, based on renewables like wind

Vision 2030: Third Medium-Term Plan (2018-2022)	The 3rd MTP builds on the achievements of the previous two, whilst prioritizing implementation of the "Big 4 Agenda".	Among the key enablers for the MTP is the need for doubling energy generation. For this, sustainable energy such as wind power is pivotal.

8.2.1.2 ENERGY SECTOR POLICIES AND LEGAL FRAMEWORKS

Framework	Objectives & Relevant Requirements	Potential interaction with the wind power & biodiversity SEA
Energy Act, 2006 (No. 12 of 2006)	• The Act promotes the development and use of renewable energy technologies including wind power • It requires that the licensee or permit holder shall comply with all applicable environmental, health and safety laws	The Act provides that the ERC, in the process of considering the issue of license to interested energy developers, shall consider the need to protect the environment and conserve the natural resources in accordance with the EMCA 1999, including undertaking SEA and/or EIA/EA as needed
Energy Bill, 2017	• Besides promoting renewable energies, underscores that all unexploited renewable energy resources under or in any land vests in the National Government subject to any rights which, by or under any written law, have been or are granted or recognised as being vested in any other person • Entrenches the feed-in tariff system, to encourage uptake of, and stimulate innovation in, renewable energy technology	Preparation of resource maps and renewable energy resources inventory: calls for a countrywide survey and a resource assessment of all renewable energy resources as will be done under this SEA for wind energy
Sessional Paper No. 4 of 2004	The aspiration of the Sessional Paper is to promote equitable access to quality energy services at least cost while protecting the environment	The Wind Power SEA's primary aim is to ensure that wind energy remains "green" by causing no net harm to the environment and biodiversity
Feed in Tariff Policy 2008 (revised 2012)	The FiT is meant to encourage investment in renewable energy technologies, by attracting private and public investors through offering a guaranteed market at a pre-determined cost, thereby reducing risks	Wind Power developers were one of the biggest beneficiaries from the FiT, with numerous proposals being received by the ERC after the policy was passed. While these projects were required to undertake the ESIA, there was still a gap in terms of overall strategic guidance to these individual projects, which this SEA hopes to fill
LCPDP – 2011-2013 (& draft 2017-2037)	The Least Cost Power Development Plan is the energy sub-sector indicative plan. The purpose of the LCPDP is to guide stakeholders with respect to how the sub-	This Plan will be the principal document that the SEA will be founded upon, in terms of the wind energy plans and projects in the pipeline

	sector plans to meet the energy needs of the nation for subsistence and development at least cost to the economy and the environment	
KGTMP – 2015-2035	• Kenya Power Generation and Transmission Master Plan undertook an identification and analysis of suitable expansion paths of the Kenyan power system, complying with the defined planning criteria and framework • The energy mix of the generation expansion plan is diverse, secure with regard to supply and costs of fuel and "clean": To develop a diverse mix of other RE sources: sustain implementation of wind and PV at moderate costs and support firm capacities of small hydro and biomass cogeneration throughout the country	The medium- and long-term plans provide important information about the future energy mix scenarios and potential generation projects including wind power
SE4All – 2030	• Sustainable Energy for All's global goals include ensuring universal access to modern energy services, doubling the rate of improvement in energy efficiency and the share of renewable energy (RE) in the global energy mix by 2030 • The Government of Kenya fully embraced the objectives of the SE4All Initiative in line with Vision 2030, and based upon significant strides in developing the framework for energy development, thanks to the Energy Policy, 2004, and Energy Act, 2006	
REA Strategic Plan 2016/17 – 2020/21	• The Energy Policy and Bill proposes to enhance the mandate of REA in the promotion and development of renewable energy • The Authority is also the custodian for information and guidance to investors on renewable energy in the country.	The SEA will interact with REA in under some of the activities proposed in this strategic plan, including: • Development and promotion of renewable energy generation systems through solar and wind mini-grids • Promotion of environmental conservation in the implementation of renewable energy projects.

8.2.1.3 NATIONAL ENVIRONMENTAL POLICIES, GUIDELINES AND REGULATIONS

Framework	Objectives & Relevant Requirements	Potential interaction with the wind power & biodiversity SEA

National Environment Policy, 2013	The NEP provides a framework for a planning and sustainable management of the environment and natural resources in Kenya. It proposes policy measures to mainstream environmental management practices in all sectors of society, and supports strong institutional and governance measures	• The NEP specifically notes that effects on the environment by infrastructural developments are distinct and unique, such as effects on flora and fauna. • It calls for conducting requisite social and environmental assessments and public participation in the planning and approval of infrastructural projects
The Environmental Management and Co-ordination Act, Cap 387, 1999	The EMCA provides for the establishment of appropriate legal and institutional framework for the management of the environment and related matters in Kenya	The Act upholds the right of every person in Kenya to a clean and healthy environment and lays the ground for achieving this. The 1999 Act has undergone various amendments, most recently in 2018.
Environmental Management and Co-ordination (Amendment) Act, 2015	This Act amends some sections of EMCA,1999 in line with the Kenya's Constitution 2010	The Amendment introduced Section 57A which provides a mandatory requirement for SEA for all Policies, Plans and Programmes
Environmental Impact Assessment/Environmental Audit (EIA/EA) Regulations, 2003	These regulations require lead agencies in consultation with NEMA to subject all public Policies, Plans and Programs, (PPPs) to SEA	Wind power energy Plan by the Ministry of Energy requires a SEA according to these regulations
The Environment Impact Assessment and Audit (Amendment) Regulations, 2016	The regulations further categorise projects requiring SEA/ESIA as low, medium or high risk, with associated assessment guidelines	Wind farms are categorised as high-risk projects under power and infrastructure sector, thus must be subjected to full SEA/ESIA as appropriate
The Environmental Management and Coordination (conservation of biological diversity and resources, access to genetic resources and benefit sharing) Regulations, 2016	These regulations outline processes and rules for the conservation of biological diversity in Kenya, while also giving mechanisms to protect and prevent exploitation of endangered and threatened plant and animal species	The specific biodiversity focus of this SEA is in line with the aspirations of these regulations
The Wildlife Management and Conservation Act, No. 47 of 2013	The Act seeks to ensure the protection, conservation, sustainable use and management of wildlife in Kenya. It prohibits any activity which is likely to have adverse effects on the	Besides turbines representing a risk for flying biodiversity, wind power projects and associated infrastructure may have adverse impacts on wildlife when located in ecologically sensitive areas including protected areas. It is

	environment and biodiversity including their habitats	important that these are avoided, and residual impacts mitigated for
Climate Change Act, 2016	This Act provides the regulatory framework for enhanced response to climate change towards a low carbon development trajectory. It requires all government institutions to mainstream climate change objectives in their planning and sectoral strategy development processes	• Wind power is a preferred renewable source of energy that reduces dependency on fossil fuels, a major source of GHGs • If properly planned and implemented, wind energy can contribute towards mitigation and adaptation to climate change
Community Land Act, 2016	This Act provides for the recognition and registration of community land rights, management and administration of community land, and the role of county government in relation to unregistered community land	Some areas identified as having potential for wind power generation are located within community land. The Act requires consultation of communities and county government when such areas are targeted for wind power projects through a process of Free, Prior and Informed Consent (FPIC)
The National Heritage and Museums Act, No 6 of 2006	This Act provides for the establishment, control, management and development of national museums and the identification, protection, conservation and transmission of cultural and natural heritage of Kenya.	Cultural heritage refers to recognised sites and monuments, while natural heritage includes animals and plants of outstanding universal value from the point of view of science, conservation or natural beauty and their habitats. These should be mapped alongside wind power potential sites to identify areas of likely overlap.

8.2.1.4 INTERNATIONAL ENVIRONMENTAL TREATIES AND CONVENTIONS

Framework	Objectives & Relevant Requirements	Potential interaction with the wind power & biodiversity SEA
Ramsar Convention (UNESCO, 1971/1994)	This Convention aims to protect important habitats designated as Ramsar sites from degradation by controlling the encroachment, pollutions, loss of wetlands biodiversity and ensuring their wise use	Wind power projects located close to wetlands could potentially affect water birds among other aquatic biodiversity
The United Nations Framework Convention on Climate Change (UNFCCC)	This Convention sets an overall framework for intergovernmental efforts to tackle the challenges posed by climate change. Among initiatives to ensure this is achieved is the Clean Development Mechanism	Sustainable wind power provides an alternative clean renewable source of energy thus reducing dependency on fossil fuels which

	under which developing countries can gain from implementing projects with real and additional emission reductions, such as wind power	is key contributor of climate change
The Convention on Biological Diversity	The key objective of the CBD is conservation and sustainable use of biological diversity. It provides that Parties shall develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity while mainstreaming it across all sectors of the economy, such as the *National Biodiversity Strategic Action Plan* in Kenya	Mainstreaming biodiversity conservation in the energy sector as envisaged in the CBD is key towards ensuring sustainable biodiversity conservation
World Heritage Convention (UN, 1972)	This Convention establishes an effective system of collective protection of the cultural, historical and natural heritage of outstanding universal value	Heritage sites should be protected from potential negative impacts of wind power development
Convention on Migratory Species – Bonn Convention (UN, 1979)	This Convention was established to protect wild animals that migrate across national and trans-national boundaries, including migratory land and sea animals.	Wind power development, especially turbines, can adversely impact flying species (birds and bats) if placed along migratory flyways. The CMS Energy Task Force works towards reconciling renewable energy developments with conservation of migratory species.
Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) (UN, 1996)	An Agreement under the Convention on Migratory Species (CMS), AEWA brings together countries and the wider international conservation community to help establish coordinated conservation and management of African-Eurasian migratory waterbirds throughout their entire migratory range.	Many of the species covered by AEWA show high vulnerability to collision with wind turbines and/or transmission lines. AEWA with CMS has produced guidance on energy infrastructure and agreed resolutions on wind power development.
Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia (Raptors MoU) (UN, 2008)	Developed in the framework of the Convention on Migratory Species (CMS), the Raptors MoU aims to promote internationally coordinated actions to achieve and maintain the favourable conservation status of migratory birds of prey throughout their range in the African-Eurasian region, and to reverse their decline when and where appropriate.	Many of the species covered by the Raptors MoU show high vulnerability to collision with wind turbines and/or transmission lines.

8.2.1.5 INTERNATIONAL GOOD PRACTICE

Framework	Objectives & Relevant Requirements	Potential interaction with the wind power & biodiversity SEA

Sustainable Development Goals (SDG)	The SDGs are universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity	This SEA will contribute to SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all It will also contribute to SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
World Bank: Environmental and Social Framework	The framework aims to ensure that the people and the environment are protected from potential adverse impacts from projects supported by World Bank. This is done through World Bank's recently revised Environmental and Social Safeguards that protect people and environment from adverse impacts (*no net loss*) and enhance environmental sustainability and social equity (*net gain*)	Biodiversity is covered in the World Bank's Environmental and Social Safeguard 6, which aligns in most respects with IFC's Performance Standard 6 (below). Learning from and incorporating relevant lessons from the World Bank's ESS into this SEA will help integrate environmental and social aspects into decisions on project selection, design and implementation (i.e., quality and risk management) and promote sustainable wind power and biodiversity conservation
International Finance Corporation: Performance Standards	IFC's Environmental and Social Performance Standards define IFC clients' responsibilities for managing their environmental and social risks. IFC uses a process of environmental and social categorization to reflect the magnitude of risk and impacts of the project it finances. IFC's Performance Standards are widely applied in the private sector, including by the Equator Principles Financial Institutions, widely influential, and regarded as a benchmark of international good practice. Developers seeking international finance for wind power projects in Kenya may often be required to align with IFC's standards, and many companies also choose to in demonstration of their environmental and social responsibility	PS6 *Biodiversity Conservation and Sustainable Management of Living Natural Resources* recognises that biodiversity loss can result in critical reductions in the resources provided by the earth's ecosystems, which contribute to economic prosperity and human development, especially in developing countries. It calls for integration of conservation needs and development priorities. PS6 introduces the concepts of *natural habitat* and *critical habitat* and requires projects to achieve *no net loss* of natural habitat where feasible, and *net gain* for critical habitat. Where residual impacts remain after the mitigation hierarchy has been fully applied, these policies thus require the implementation of biodiversity offsets
Japan International Cooperation Agency (JICA): Guidelines for Environmental and	The guidelines encourage project proponents to ensure appropriate consideration for environmental and social impacts in project they support. It seeks to avoid or minimise development projects' impacts on the	Among the guidelines principles is the use of Strategic Environmental Assessment (SEA) when conducting Master Plan Studies and encouraging project proponents to ensure environmental and social considerations

Social Considerations	environment and local communities, and to prevent the occurrence of unacceptable adverse impacts	from an early stage to a monitoring stage
African Development Bank (AfDB): Environmental Safeguard Policies	The AfDB Environmental Safeguard Policies provide a framework for identifying risks, reducing development costs whilst improving project sustainability.	• The safeguards require that borrowers or clients conduct SEA and/or ESIA and develop an ESMS • They are also required to identify and assess the potential opportunities for, risks to, and impacts on biological diversity and ecosystem services.
CMS and AEWA guidelines on deployment of renewable energy technologies[22]	Provide expert guidance on minimising the impacts of renewable energy technologies, including wind power, on migratory species. This includes steps in the planning, design and policy process as well as mitigating and avoiding possible impacts by renewable energy technologies.	The guidance calls for Strategic Environmental Assessment (SEA) of national/sub-national plans, programmes and policies for renewables. Sensitivity mapping tools should be used to identify high-risk areas for migratory species. At project level, there is need to identify impacts on migratory species and manage these through the mitigation hierarchy of avoidance, mitigation or compensation. The EIA process should include an adaptive management strategy with continuous monitoring and scientific evaluation, to reduce impact uncertainties and improve mitigation measures over time.

Additional guidance documents are listed in Annex A.3.

8.3 ENABLING ENVIRONMENT FOR WIND POWER DEVELOPMENT IN KENYA

The updated Kenya Wind Atlas and associated assessments in the wind prospectus (WinDForce 2013) revealed that the country has immense wind power potential; large tracts of lands have been identified with a rich wind energy resource, especially in many parts of northern and eastern Kenya that have so far remained little developed. However, several factors still constrain wind energy development in Kenya, including regulatory environment, lack of financial resources, inadequate infrastructure and extent of grid, and limited capacity (Tigabu 2016; IREK 2018; see Chapter 7).

8.3.1 KEY POLICY MEASURES AND INCENTIVES FOR RENEWABLE ENERGY

The Government of Kenya recognises the key role of renewable energy sources in enhancing the country's electricity supply capacity and diversification of generation sources. To this end, the MoE continues to

[22] https://www.unep-aewa.org/sites/default/files/document/stc10_24_renewable_energy_guidelines.pdf

improve the policy and regulatory framework for renewables (including wind) in Kenya. Section IV of the Energy Bill 2017 is on Renewable Energy, with a whole clause (90) on Promotion of Renewable Energy. Further, Clause 106 is on the Renewable Energy Feed-in Tariff System with four key objectives: (i) catalysing the generation of electricity through renewable energy sources; (ii) encouraging locally distributed generation thereby reducing demand on the network and technical losses associated with transmission and distribution of electricity over long distances; (iii) encouraging uptake of, and stimulating innovation in, renewable energy technology; and (iv) reducing greenhouse gas emissions by lessening reliance on non-renewable energy resources. It provides investment security and market stability for private investors, by encouraging them to operate their power plants prudently and efficiently to maximise returns.

8.3.1.1 FEED IN TARIFFS FOR WIND POWER

In 2008, Kenya first launched a Renewable Energy Feed-In Tariff policy which aimed at promoting all renewable energy resources, including wind energy. A Feed-in Tariff allows power producers to sell generated electricity to an off-taker at a pre-determined tariff for a given period. The current revised FiT policy (2012) can be downloaded at: http://www.energy.go.ke/ or http://www.renewableenergy.go.ke/. The FiT was meant to attract private sector capital in wind resource electricity generation. The FiT is defined in the FiT Policy for small (up to 10 MW) and large renewable energy projects, and is summarised in Table 8-1 for wind power projects. The FIT provides for wind generated electricity a fixed tariff of the order of USD Cents 11.0 per kilowatt-hour of electrical energy supplied in bulk to the grid operator at the interconnection point (Table 8-1). The FiT applies for 20 years from the date of the first commissioning of the wind power plant.

Table 8-1: The FiT values for small and large wind power projects connected to the grid

Installed capacity (MW)	Standard FiT (USD / kWh)	Percentage Scalable portion of the Tariff	Min. capacity (MW)	Max. capacity (MW)	Max. Cumulative capacity (MW)
0.5-10	0.11	12%	0.5	10	--
10.1-50	0.11	12%	10.1	50	500

According to WinDForce (2013), the FiT led to substantial interest among potential investors to invest in Kenya's renewable energy sector. The MoE received numerous applications under this mechanism under the different renewable energy technologies. On wind energy only, the Government received a total of 236 applications by 2013, with a combined capacity of 1,118 MW, out of which 20 totalling 1,008 MW were provisionally approved. Environmental factors were not directly considered in these initial approvals which mostly focused on the wind energy potential, but they were still subject to approved project-level ESIAs before implementation could begin.

8.3.1.2 PROPOSED ENERGY AUCTIONS

According to Frost & Sullivan's *Global Renewable Energy Outlook, 2018*[23], the number of countries cutting subsidies to renewable energy continues to rise globally, forcing the market to consider purely commercial

[23] http://www.frost.com/sublib/display-report.do?id=K2AC-01-00-00-00

alternatives to feed-in tariffs, such as competitive auctions and private-sector power purchase agreements, as happened with the amendment of Germany's Renewable Energy Act (EEG) in 2016 to coordinate a switch from feed-in tariffs to auctions as the main policy for larger renewable energy projects[24].

The feed-in tariff model has been operational for about ten years in Kenya, but has been criticised for making power tariffs expensive. The Government of Kenya has initiated discussions to abolish the current feed-in tariff system and replace it with an energy auction tariff that will see the government award energy contracts to companies offering the lowest electricity tariffs (see Box 8-1). The intent is to allow electricity consumers to benefit from technological advancements that have seen a reduction in the production costs for most of the renewable energy technologies. Energy auctions are also expected to spur significant growth in the renewable energy sector, making energy cheaper, more readily available and reliable to individual consumers and businesses.

The proposed policy would see Kenya’s government buying electricity from Independent Power Producers (IPPs) through competitive auctions (Cannon 2018). The auction system will allow the government to select power producers offering the lowest prices to build power generating plants which will be connected – either by the IPP or a government entity – to the national grid. Data collection and feasibility studies are underway in readiness for renewable energy auctions. The Renewable Energy Auction system will be introduced for projects above 10 MW.

As indicated, auctions have been used by many countries transitioning to renewable energy sources and related technologies; South Africa and Zambia are two relatively successful cases in Africa. However, a crucial consideration for Kenya, is that auction systems have proven unfavourable for geothermal development as they favour intermittent resources at cheaper prices[25]. Further, though auctions may potentially drive down costs, that will only happen if proper oversight and planning are instituted e.g., the capacity of projects which will qualify to participate in the auction, frequency of bidding, the criteria for project developers to qualify to participate in the auction[26] (see Box 8-1 for further details).

It is important that Kenya’s electricity agenda is driven by true energy needs, as auctions work best if demand for electricity exceeds supply; scarcity is vital for auctions to work efficiently. It can be achieved by setting high prequalification requirements, albeit this could favour larger market players with more robust financial capabilities (De Vos and Klesmann 2014). South Africa can provide some lessons around regulatory factors which promote certainty in energy deployment, including measures to ensure that projects achieve grid connection, which is important in assuring delivery of the renewable energy programs. Such measures may include a penalty system and strong and coordinated oversight from a suite of stakeholders (e.g., Toke 2015).

According to the 2018 report from Frost & Sullivan, the future of renewable power will be hybrid, with special emphasis on storage solutions. The pace of growth will depend on the level of government backing in terms of setting up support mechanisms, including regulatory frameworks, to drive progress towards the 100 % renewable energy generation. To succeed, Original Equipment Manufacturers (OEMs) need to evolve from providers of equipment and related services to providers of power generation solutions. Solutions such as remote monitoring and diagnostics, unplanned maintenance and performance-enhancing digital

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[24] https://book.energytransition.org/renewable-energy-act-feed-tariffs-and-auctions

[25] http://www.thinkgeoenergy.com/kenya-considering-auction-system-to-replace- feed-in tariffs/

[26] https://www.kenyaengineer.co.ke/kenyas-energy-security-energy-auctions/

applications will become increasingly important. Developing strategic partnerships with other renewable OEMs, plus storage and grid service start-ups will open numerous growth opportunities for participants.

Box 8-1: Renewable Energy Support Mechanisms: Feed-In Tariffs and Auctions

There are two perspectives on regulation in the energy sector. A legalistic approach considers it to consist of laws and rules enforced by government and agencies vested with regulatory power. In this case, regulation targets efficiency in energy provision, fair pricing, equality of access and environmental sustainability. A more economics-based perspective sees the role of regulation as creating conditions for efficient functioning of markets, which may not necessarily satisfy social equity considerations or concerns about environmental externalities. Both approaches have their strengths and weaknesses. Implementing innovative renewable energy policies in reality requires both proactive government action and market (and societal) support. Consequently, the renewable energy sector typically involves a host of policy tools and mechanisms, two key ones being Feed-in Tariffs and Energy Auctions.

A **Feed-In Tariff (FIT)** provides renewable energy generators with a fixed price for the energy which they produce. The FIT is set for each technology individually and is paid for a fixed number of years. This increases predictability and stability and allows for long-term planning, thus encouraging investment. In some countries the FIT is funded through electricity utility bills, so the costs are passed down to the consumers. Elsewhere an increase in consumer bills was deemed unacceptable and government budgets have been set aside for the FIT.

Governments may alternatively open **renewable energy auctions**. These will specify the capacity (kW) or the electricity generation (kWh) that is up for auction, as well as the generation technology and sometimes the generation location. Project developers can than submit a bid to the auction, outlining their project proposal and stating the price per unit of electricity at which they will be able to realise their project. The government then evaluates the different offers, ranking them based on their price and other criteria. A power purchasing agreement is signed with the successful bidders. Some important differences with FiTs are outlined in the table below.

Level	FIT	Auctions
Government	Risk is shifted towards the government	Lower risk for government
	Can be very costly, but if funded by consumers there is no burden on the public budget	Project costs are set far in advance, offering more control and certainty over the final total cost
	Easier to target the policy towards certain groups	Should be open to all. Difficult to target towards certain groups
Developers	Lower risk for project developers	Risk is shifted towards project developers
	Lower costs for project developers	High planning and transaction costs due to pre-auction requisites
	FITs make it easy for new companies to enter the market and allow small companies to be competitive	Difficult for small/new companies due to high risk as well as large planning and transaction costs
Innovation	Good at providing support for new technologies	Suited for slightly more established technologies
Market Development	Especially in fast-changing markets the FIT often does not reflect the true market price	If designed well and there is enough competition, then auctions are a good way of discovering the true market price
	FITs offer very stable condition during their running time	Offers stable conditions, but gaps between auctions can lead to discontinuity and start-stop market development

8.4 ENERGY VS ENVIRONMENT POLICY FRAMEWORKS

As the review above outlines, Kenya has a well-developed policy and regulatory framework for the energy sector, including wind power, and for the environment. However, energy and environmental planning have not been brought together in a strategic way. This means that the interface between the two is only at the project level, through the ESIA process. This should serve to address any significant biodiversity risks at project level, but is not well suited to consider and address cumulative impacts, especially for the wind power sector. Many of the species potentially impacted by wind power are wide-ranging and/or migratory, so individuals may be at threat not just from one wind farm but many – quite a different situation to the footprint-focused impacts that ESIA is largely designed to address. This thus represents a policy and regulatory gap that possibly could undermine Kenya's policy aims on environment as well as the country's international commitments. Recommendations to address this are outlined in section 11.3.

9 BIODIVERSITY IMPACT ANALYSIS

9.1 CONTEXT

The bird and bat species potentially impacted by wind power provide a range of vital ecosystem services, including pest control and pollination. Vultures provide crucial ‘clean up’ services by disposing of carcases. These species are also integral components of the ecosystems, maintaining various ecosystem functions from which services flow. Yet, they are among the most threatened groups of birds worldwide. According to BirdLife International and the IUCN, about 75% of all vulture species are listed as threatened or near-threatened, the majority classed as Endangered or Critically Endangered. Vultures in Africa are in a conservation crisis (Ogada et al. 2015). Africa's vultures face myriad threats, the most significant of which are poisoning and trade in traditional medicines; mortality caused by power lines and wind turbines is now adding to these pressures (Botha et al. 2017). Vultures forage across very wide ranges, and are particularly prone to collision because of their visual field and flight behaviour – birds look down while foraging and have a ‘blind spot’ directly ahead. This makes them particularly vulnerable to wind power impacts.

In Kenya, vultures are in steep decline owing mainly to incidental poisoning that stems from livestock losses to predators. Many other birds of prey, while not as severely threatened as vultures, are also in decline. In Kenya, anecdotal reports and a limited number of studies suggest severe declines over the last 20-30 years across a suite of formerly common raptor species, resulting from extensive habitat conversion, persecution, reduction in food supply and, increasingly, collisions and electrocutions from power lines.

Kenya is part of a major flyway for soaring birds, and other species, that migrate to and from the Palaearctic region. Other species make long-distance movements within the region and the African continent, including two flamingo species that move in large numbers between the alkaline lakes dotted along the Rift Valley in Tanzania, Kenya and Ethiopia.

Kenya’s avifauna is one of the most diverse on the continent, reflecting its biogeographic position and the remarkable variety of habitats across the country. Kenya’s birds include many species that are range-restricted and/or globally threatened, among them species like the endemic, Endangered Sharpe’s Longclaw *Macronyx sharpei* that could be impacted by displacement effects from wind turbines in its highland grassland habitat.

O’Shea et al. (2016) recently reviewed multiple mortality incidents in bats. Before 2000, intentional killing by humans was the major cause of multiple mortalities, but this has now been overtaken by disease (the outbreak of white-nose syndrome in North America) and by deaths at wind farms, related to collisions or barotrauma[27] at wind turbines. In Kenya, bats are relatively little-studied, and few data are available on population trends. The main current threats appear to be habitat loss and degradation, but poorly-sited wind turbines again have the potential to add to these pressures. Some bat species are very wide-ranging, and may travel close to 90 km nightly from their roosts to forage (e.g. Fahr et al. 2015), putting them at greater risk from multiple wind power developments.

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[27] It has been assumed in the past that barotrauma – injury brought about by sudden pressure changes – causes bat fatalities at wind farms, but this is not proven and is increasingly thought to be unlikely.

A recently published analysis showed that Kenya has among the world's highest concentrations of bird species vulnerable to wind power impacts (Thaxter et al. 2017). While bird 'sensitivity maps' have been produced for countries along the Rift Valley flyway to the north[28], there has been no similar assessment yet in Kenya. This lack of reliable information means that wind power developers are working in the dark in respect of biodiversity impacts. This issue is already creating significant practical problems. For example, one major windfarm in development since 2008 was discovered to be in a highly sensitive location for Critically Endangered[29] vulture species. This can create a difficult and expensive situation for developers including:

- Civil society opposition that causes expensive delays and creates challenges in securing external financing, as most international development finance is tied to strict environmental safeguards that do not allow damage to sensitive biodiversity
- Expensive and complex mitigation actions laden onto to windfarm set-up and operations – involving many millions of dollars over the course of a project lifespan, especially if added at a late stage of project development

At broader Government level, significant impacts on sensitive or threatened species are counter to Kenya's national conservation objectives, and may breach obligations to treaties such as the Convention on Biological Diversity, Convention on Migratory Species (and its African-Eurasian Waterbird Agreement and Raptors MoU) and Convention on Wetlands. It is usually unfeasible to change locations to avoid impacts at a late stage of project development. This highlights the crucial importance of good biodiversity information being available at the early planning stage, in order that sensitive sites can be avoided, or impacts minimised via early project design, in-line with the mitigation hierarchy (see section 10.2.1)[30].

This section of the SEA identifies where sensitive areas for biodiversity may exist in relation to wind power at national level. This mapping is not a substitute for project-level ESIAs that address site-specific environmental issues. The sensitivity mapping is not intended to designate 'no-go' areas, but to highlight critical biodiversity-related issues that wind power planners and developers in Kenya should bear in mind to avoid adverse impacts and reduce risks to their projects and investments.

9.2 WIND POWER IMPACTS ON BIODIVERSITY

Wind is regarded as an environmentally benign source of electrical power. The 'footprint' of wind farms is generally relatively small, and careful site layout and construction management can usually avoid or minimise significant biodiversity impacts on the ground. Wind power development can also occur with relatively little risk to birds and bats if a structured approach is followed to planning, siting and operating wind farms. However, wind farms are known to have a number of potential biodiversity impacts, which can be significant in themselves and/or can interact synergistically with other pressures on species or ecosystems. These potential impacts need to be understood, avoided where possible, and managed where unavoidable.

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[28] https://maps.birdlife.org/MSBtool/

[29] Critically Endangered' is the highest category of extinction threat for wild species under the internationally-recognised IUCN Red List of Threatened Species

[30] According to the Cross Sector Biodiversity Initiative, the mitigation hierarchy involves a sequence of four key actions—'avoid', 'minimize', 'restore' and 'offset'—and provides a best-practice approach to aid in the sustainable management of living, natural resources by establishing a mechanism to balance conservation needs with development priorities. http://www.csbi.org.uk/our-work/mitigation-hierarchy-guide/

9.2.1 HABITAT LOSS, DISPLACEMENT OR DEGRADATION

Compared to other renewable energy sources, such as hydro and solar, the direct footprint of wind power projects is usually relatively small. However, impacts may not be trivial. Construction activities typically include land clearing for site preparation and access routes; excavation, blasting, and filling; transportation of supply materials and fuels; construction of foundations involving excavations and placement of concrete; operating cranes for unloading and installation of equipment; construction and installation of associated infrastructure; installation of overhead conductors or cable routes (above ground and underground); and commissioning of new equipment (World Bank 2015). Decommissioning activities may include removal of project infrastructure and site rehabilitation. In sensitive habitats, these activities need to be carefully managed to avoid unnecessary impacts.

Displacement from around wind turbines or transmission lines can result in effective loss or degradation of habitat for certain species. Many open-country birds avoid foraging or nesting close to tall structures, which can provide perches for predators (e.g. Gómez-Catasús et al. 2018). Barrier effects have also been reported, where birds divert from their usual flight paths to fly around wind farms: these seem unlikely to be very significant at the level of individual wind farms, but could be where developments block traditional flight paths or many developments close together require birds to fly much longer routes (Drewitt & Langston 2006). Barrier effects could also exist for wildlife moving on the ground, though no significant examples have been reported (AWWI 2018).

Beyond the footprint itself, activity induced by the project may also cause biodiversity impacts. For example, pressure on natural habitats or resources may be increased by in-migration of workers, increased economic activity in the surrounding area, improved access along transport links, or resettlement of displaced households. As wind farms are often in remote locations, roads may have to be built or upgraded not only on site but to allow transport of bulky turbine blades and heavy tower sections, as well as to access and service transmission line routes. Roads have many negative impacts on biodiversity, through barrier effects, wildlife collisions with traffic, and increased human access putting greater pressure on natural resources.

Less obviously, ecological shifts may occur when certain species, such as birds of prey, either avoid or are killed by wind turbines. In India, ecological communities at a wind farm site changed markedly in response to the reduced presence of avian predators (Thaker et al. 2018).

9.2.2 MORTALITY AND INJURY FROM COLLISIONS OR OTHER INTERACTIONS WITH WIND TURBINES

To people, wind turbines may look conspicuous and easy to avoid. However, they pose a significant risk to some bird and bat species.

Turbine blades appear to move slowly, but the blade tips have high angular velocity, routinely moving at 200 km/h or more on large turbines. Many birds have been killed or injured by collisions with turbine blades (and sometimes towers) at wind farms around the world. Collision rates vary greatly among species, and are influenced by size, manoeuvrability and behaviour. Some species, such as vultures, are particularly prone to collisions because of their visual field and flight behaviour, which create a ‘blind spot’ in front of the bird.

Bats are also at risk from wind turbines. The causes of bat mortality are not well understood. Both echo-locating species and other bats may be killed, and mortality rates also vary substantially among species. Apart from collisions, ‘barotrauma’ – sudden air pressure changes caused by the rapidly sweeping rotor blades – is thought to be a factor in some bat deaths (Baerwald et al. 2008), but this remains unproven. Some bat species appear to be attracted to wind turbines, which may put them at greater risk.

Kenya is rich in bat biodiversity, with at least 104 species (belonging to 11 families) (Patterson & Webala 2012, Musila et al. 2019). Bats thus make up more than a quarter of Kenya’s 390+ mammal species (Musila et al. 2019). However, while wind turbines are a notorious hazard for birds, less well known is the danger they pose to the rich bat fauna in Kenya. Evidence elsewhere suggests that turbines kill more bats than birds, and the numbers of the dead may be substantial (Rydell et al. 2012). Increased mortality rates can negatively affect bat populations because bats are long-lived and have low reproductive rates, projecting a slow population growth and limited ability to recover from any population declines, and increasing the risk of local extinctions (Arnett et al. 2008). Migrating bats such as the Straw-coloured Fruit Bats (*Eidolon helvum*), which can travel long distances (Thomas 1983, Richter & Cumming 2008, Ossa et al. 2012), may make up most of those fatalities because they often navigate through areas dotted with wind farms. In addition, carcases of cave-roosting bats, such as the Long-fingered bats (*Miniopterus* spp.) have also been reported.

Exactly why bats die at wind turbines remains unknown. It is possible that wind turbines interfere with seasonal migration, commuting and mating patterns in some bat species. The siting of turbines may be an issue for bats not only because of the risk of direct collision if turbines are placed on migration or commuting routes or in important foraging habitat, but also because of potential displacement from foraging habitat. This supports the need for case by case assessment of the potential impacts of proposed installations on bat species.

9.2.3 MORTALITY AND INJURY FROM COLLISIONS WITH TRANSMISSION LINES

Electrical connections within a windfarm are usually buried underground, but above-ground transmission lines typically take the generated electricity to the national grid. Bird deaths by electrocution can occur on transmission lines, but this is unusual, in contrast to the electrocution incidents that commonly occur on poorly-designed distribution lines. A more significant threat is collisions, where birds fly into the near-invisible wires, most often the thin earth wire that usually runs some distance above the conducting wires, and which is often hard to see. Collisions have also been reported with the stay-wires of masts and towers.

Large bird species with poor manoeuvrability are especially vulnerable, including cranes, storks and bustards, but also vultures and other birds of prey. Fast-flying flocking birds, such as sandgrouse, may also be affected. For some, such as threatened bustard species, this is a significant risk and may have impacts at population level.

Most species at risk are active during the day, but some, like flamingos, mainly move at night, when wires are particularly hard to see.

9.3 VALUED ENVIRONMENTAL COMPONENTS (VECS)

The assessment aimed to identify the most significant biodiversity risks through identification and prioritisation of ‘Valued Environmental Components’ or VECs. This term is drawn from cumulative impact assessment, where VECs are defined as ‘sensitive or valued receptors whose desired future condition determines the assessment end points to be used in the cumulative impact assessment process’ (IFC 2013). ‘Receptors’ in this case means species or taxon groups of birds and bats, or particular sites.

Considering the potential impacts of wind farms, the assessment aimed to identify and prioritise:

1. Site VECs holding sensitive biodiversity that could be impacted by a wind farm’s footprint, or by indirect impacts
2. Site VECs holding sensitive biodiversity that could be impacted by collisions with turbines or transmission lines
3. Bird and bat species VECs at high risk of collision with turbine blades or transmission lines.

The suite of potential site VECs included all terrestrial or wetland sites in Kenya holding natural habitat and/or supporting priority species VECs. The suite of potential species VECs included all bird and bat species, both resident and migrant, in Kenya. VECs were identified and prioritised through a stakeholder-led process, described below.

9.4 MITIGATION

At regional to global scales, wind energy is generally considered an environmentally benign technology. However, wind energy facilities are shown to kill and injure birds and bats and can result in the loss of habitat for some species (NRC 2007). To the extent that we understand how, when, and where wind-energy development most adversely affects organisms and their habitat, it will be possible to mitigate future impacts, e.g., through careful siting decisions.

This SEA first sought to identify (geographical) areas for lowest potential biodiversity impact and risk for wind power development in Kenya, then propose mitigation actions for areas of medium to high risk. The mitigation measures proposed follow the mitigation hierarchy. The interpretation of the mitigation hierarchy used in this SEA considers that understanding an impact is a necessary precondition to the design of mitigation measures. Once there is a basic understanding of an impact that allows for its prediction and assessment, impact avoidance, minimisation, restoration and offset (compensation) are the available options to mitigate impacts, in hierarchy from most to least desirable.

The mitigation hierarchy is explained in more detail, and recommended mitigation measures outlined, in section 10.2.

9.5 SENSITIVITY ANALYSIS

The sensitivity analysis formed a central part of this assessment. The analysis aimed to address a key question: what is the spatial pattern of biodiversity risk for wind power in Kenya, and how does this overlap with planned and potential wind power developments?

9.5.1 STEPS IN SENSITIVITY ANALYSIS

Figure 9-1 shows the key steps in undertaking the sensitivity analysis for species and site VECs. This is a simplified sequence, as some steps (e.g. data compilation and field surveys) took place in parallel.

9.5.2 REVIEW OF APPROACHES AND SPECIES INFORMATION

An input paper for the biodiversity expert workshop (Appendix 1) summarized the approaches taken by BirdLife International’s Migratory Soaring Bird (MSB) project (Allinson 2017) and by BirdLife South Africa (Retief et al. 2010) to map biodiversity sensitivity to wind power development.

Figure 9-1. **Outline of key steps in sensitivity analysis for species and site VECs**

9.5.2.1 BIRDLIFE INTERNATIONAL APPROACH

For the MSB project, BirdLife International assessed a species-level Sensitivity Index by combining:

A Species Vulnerability Index, a relative measure of each species' collision susceptibility based on an assessment of its body mass, flight style, behaviour and documented incidents of collision.

An Extinction Risk Index, a score based on the species' IUCN Red List category, ranging from 1 for Least Concern species to 10 for Critically Endangered species.

For each site being assessed, this Sensitivity Index is multiplied by the proportion of a species' population recorded at a site, based on maximum counts. An overall site sensitivity index is found by summing all the individual species indices. Using this, sites are placed in a sensitivity category ranging from potential to outstanding; or 'unknown' if there is insufficient information.

This approach works well for sites where migrant birds are highly concentrated on passage ('bottlenecks'), but is less easy to apply to the Kenyan situation, where site-based counts are lacking for many of the species likely to be at greatest risk.

9.5.2.2 BIRDLIFE SOUTH AFRICA APPROACH

The South African approach is based not on site counts but on summing sensitivity scores for species within 'pentads' – the 5'x5' grid square (roughly 9 x 9 km) used for the second iteration of the South African Bird Atlas (SABAP 2). The steps in the process are outlined in Figure 9-2.

1 Create a species list for all birds to be considered for inclusion in the map. This includes species believed likely to be influenced by wind farms.

2 Assign a priority score to each species, through three sub-steps:

i. Assign a conservation score to each species
ii. Assign a risk score to each species
iii. Combine to find the priority score

3 Calculate the sensitivity value for each pentad on the map, through three sub-steps:

i. Determine which species have been recorded at pentad level
ii. Sum the total priority scores for all species recorded to obtain a sensitivity score
iii. Add the sensitivity score for the status of the land to the above species sensitivity score

4 Add the sensitivity values to the map.

Figure 9-2. Outline of the South African pentad-based approach to scoring species sensitivity to wind power impacts

9.5.2.3 IFC CUMULATIVE IMPACT ASSESSMENT APPROACH

For the Tafila project in Jordan, the International Finance Corporation (IFC 2017) developed a step-wise framework to prioritise VEC species. A component of this framework uses a structured matrix to assign vulnerability scores based on BirdLife's Species Vulnerability Index (where available) and threat category on the global or regional Red List. Different approaches are defined for migratory soaring birds, other migrant/wintering species, resident/breeding raptors, and other resident/breeding species.

9.5.2.4 SPECIES INFORMATION

Thaxter et al. (2016) collated information globally on bird and bat species mortality from wind turbine collisions, and used this to (a) examine the key traits influencing collision susceptibility, (b) model the predicted collision susceptibility for all bird and bat species.

To inform expert discussions on species sensitivity, we extracted lists of the Kenyan species of birds and bats modelled to be at high collision risk by Thaxter et al. (2016, supplementary online material). These lists included bird species with a predicted risk index above 0.046 (approximately the top 10% of species), and bats with a predicted risk index above 0.806 (approximately the top 25% of species). A larger proportional set was taken for bats, as much less is understood about the risk factors for collision, the data underlying the model are very incomplete and the model itself is thus less robust than for birds.

We reviewed these lists to add some apparently overlooked species and screened and annotated them to flag species with restricted Kenya distributions, and those confined to habitats were wind power development is unlikely (e.g. tropical forest and alpine moorland). The lists provided for the expert workshop are available in A.10.

9.5.3 IDENTIFICATION OF PRIORITY VECS BY BIODIVERSITY EXPERT WORKSHOP

The SEA is a national assessment covering a broad suite of species and sites. We therefore decided to use a stakeholder-led approach to identifying and categorizing priority VECs, rather than a fully structured framework as used by IFC (2017).

This was accomplished through a biodiversity expert workshop held on 13 March 2018 in Nairobi. The workshop brought together 23 bird and bat experts, along with representatives from Power Africa and Kenya government.

9.5.3.1 SPECIES VECS

Working groups focused on bats, birds of prey, and other bird species. VECs were identified and categorized based on:

- An assessment of collision risk (using BirdLife's Species Vulnerability Index, modelled risk from Thaxter et al. 2017, and species' characteristics and behaviour compared to a checklist of risk factors
- Species' global and/or regional threat status, and demographic factors (declining population, long generation length) that would make population-level impacts more likely from raised mortality rates

The conceptual framework below (Figure 9-3) was used by expert participants to assign a sensitivity category (low, moderate, high or very high) score to each VEC.

Species and site VECs identified in the workshop were further reviewed and consolidated by The Biodiversity Consultancy following the workshop. Dr Paul Webala provided additional input for bats.

A total of 144 VEC species were identified and prioritised in the very high, high and moderate sensitivity categories (Table 9-1). Over half of these were raptors, reflecting the high collision risk and often high threat status among this particular group. Species categorized as low risk were not considered further in the assessment.

Table 9-1. Summary of species VECs identified in different sensitivity categories

	Risk Category			
	Very High	**High**	**Moderate**	**Total**
Raptors	10	43	24	77
Other Bird Species	2	16	23	41
Bats	0	18	8	26
Total	12	77	55	144

		Vulnerability (threat status and demography)		
		Low	Medium	High
Collision risk	High	Moderate	High	Very high
	Medium	Low	Moderate	High
	Low	Low	Moderate	Moderate

Figure 9-3. Conceptual framework for assigning sensitivity category to VEC species. Species classed as low sensitivity were not considered further in the analysis.

9.5.3.2 SITE VECS

Eight potential types of site VECs were identified by the expert participants, with examples (Table 9-2) and suggested data sources

Table 9-2. Eight potential types of site VECs and examples identified in the expert workshop

Feature	Examples identified in workshop
Bat Roosts	Chyulu, Elgon, Mbale In Vihiga, Menengai, Naivasha, Suswa, Coastal caves
Bird Nest and Roost Colonies	Rüppells Vulture cliff colonies at Kwenia, Hell's Gate, White-Backed Vulture nest sites In Nairobi NP and Masai Mara, tern nesting islands along coast, Great White Pelican nest islands in Elmenteita, L. Victoria 'Bird Island'
Key Biodiversity Areas (KBAs) including Important Bird and Biodiversity Areas (IBAs)	Both listed and potential KBAs: including Kulal, Marsabit, Huri Hills
Migratory Routes	Somali-Maasai Biome Corridor from Meru through Tsavo; around Lake Victoria Shoreline; Timau (stopover site for raptors and atorks), Tana River Delta, Mida Creek; Rift Valley from Magadi to Turkana for Flamingos and other Species
Protected Areas (Including Conservancies)	Namunyak, Lolldaiga
Slopes	Rift Valley Scarps

Feature	Examples identified in workshop
Wetlands	L Jipe, L Logipi, L. Ol Bolossat (cranes), Kitale (cranes), Sabaki River Mouth, Mwea & Bunyala Rice Schemes

Sensitivity scores were assigned to site VECs pentad-by-pentad. Scoring was based on the number of different types of site VEC located in a pentad, and (where relevant) the presence of VEC species triggering IBA identification (see section 9.5.8.6).

9.5.4 IDENTIFICATION OF DATA SOURCES AND GAPS

The expert workshop further identified likely data sources for species and site information. The expert group recognized that there are substantial gaps in the data available on the status, distribution and movements of species VECs in Kenya. These gaps were assessed prioritized and targeted field surveys recommended to address these priorities.

9.5.5 FIELD SURVEYS TO FILL DATA GAPS FOR BAT SPECIES

A team led by Dr Paul Webala (Maasai Mara University) surveyed bats in coastal counties of Kenya from 24 October – 5 November 2018. The aim was rapid identification and mapping of key sites for bat species at the Kenya coast. Coastal Kenya was targeted because it has substantial potential for wind energy development, combined with a number of highly colonial bat species whose status is very poorly known.5

The survey focused on assessing the status of known roosts, locating additional roosts, and ascertaining numbers and status of colonies, so that key sites can be identified (Ralph et al. 2015). The Kenyan coast contains granitic and coral caves with thousands of individuals of vulnerable species such as the African Sheath-tailed Bat (*Coleura afra*) and Long-fingered bats (e.g., *Miniopterus africanus*, *M. minor*, *M. natalensis*). The area also supports frugivorous bat species such as the tree-roosting and migratory Straw-coloured Fruit Bat (*Eidolon helvum*). The survey used a complementary set of methodologies: asking about the occurrence of bats among local communities, searching for and counting at roosts, and occasional mist-netting.

Three roost sites (on trees and buildings) were located for frugivorous bat species while 14 cave roosts (including a borehole and pit latrines) were mapped for both insectivorous and frugivorous species in four target counties (Taita Taveta, Kilifi, Mombasa and Kwale). Additionally, the team mist-netted bats at three sites and assembled a local reference call library from insectivorous bat vocalizations.

The survey revealed a rich bat assemblage comprising of 23 species and over 11 million individuals. Most of these species are classified as Least Concern on the IUCN Red List of Threatened Species, but Hildegarde's Tomb Bat *Taphozous hildegardeae* Thomas, 1909 is listed as Vulnerable and the African Straw-coloured Fruit Bat *Eidolon helvum* (Kerr, 1792), Decken's Horseshoe Bat *Rhinolophus deckenii* Peters, 1868, Giant Leaf-nosed Bat *Macronycteris gigas* (Wagner, 1845), and Striped Leaf-nosed Bat *M. vittata* (Peters, 1852) are listed as Near Threatened. Of these species of conservation concern, *Eidolon helvum* and *Taphozous hildegardeae* are potentially at high risk from wind turbines. Some Least Concern species could also face high fatalities at wind turbines because they are either migratory or fly at high altitude.

Further details of the bat surveys can be found in A.15.

9.5.6 FIELD SURVEYS TO FILL DATA GAPS FOR BIRD SPECIES

Bird surveys were envisaged to include two components: (a) satellite tagging of vultures, (b) surveys and counts.

Tagging was undertaken in March 2018 to allow time for movement data to accumulate before substantive data analysis.

Vultures were chosen as the focus for satellite tagging, because they are:

- Exceptionally mobile, often moving over very long distances but with poorly understood daily and seasonal ranging patterns
- At very high risk of collision with wind turbines, because of their flight behaviour and visual fields
- Undergoing rapid population declines (through mortality from incidental poisoning, combined with habitat loss and other factors) that put the majority of species at high risk of extinction.

The Peregrine Fund and North Carolina Zoo had already satellite-tagged a number of vultures in different parts of Kenya. The additional birds tagged were intended to provide complementary data from far northern Kenya, where wind-power potential is high but current knowledge of vulture status and movements is very limited.

Fieldwork took place in Jaldesa Conservancy, Marsabit County, far northern Kenya in March-April 2018. Despite practical difficulties caused by heavy rain and swarms of biting flies, ten White-backed Vultures were successfully trapped and fitted with tags. Unfortunately, four tags later stopped functioning, apparently because they dropped off birds due to problems with the clips used to fasten the harness. One tag was tracked and retrieved from high in a tree, and later re-fitted to a juvenile White-backed Vulture in Ol Pejeta Conservancy. Further details on the vulture tagging are available in A.13.

The biodiversity expert workshop identified the area east of Lake Turkana in northern Kenya as a major information gap. This area was considered likely to be important both for high-risk VEC species and for wind power development. From 14-28 October 2018 a team from The Peregrine Fund undertook a two-week survey in Marsabit and Samburu counties to identify breeding, roosting and migratory flyways for large birds. A full report is in Appendix 6. Data were gathered by means of a raptor road count over 1183 km, four vantage point surveys at Huri Hills, Mt Kulal and Mt Nyiru, foot searches, and opportunistic sightings. Across all survey types, the team recorded 1214 individual raptors, comprising 38 species. Palearctic migrants accounted for 54% of all raptors observed. The team recorded 17 individual bustards, the majority were Heuglin's *Neotis heuglinii*. Other large birds recorded were mainly water birds observed along the shoreline of Lake Turkana.

This region of northern Kenya consists of important migratory corridors and habitats for local and migrant raptor species. The team noted that Mt Kulal lies along a major migratory corridor adjacent to the shoreline of Lake Turkana, with the Lake Turkana Wind Power Project in the middle of this migratory corridor. Huri Hills was an exceptional location for resident raptors, bustards, and other grassland specialists in particular. Thick mist covered the hills in the mornings while the team was present, which would increase collision risks for birds were any wind turbines present. Other important sites confirmed include the cliffs and adjacent area around the base of Mt Ololokwe. The team was unable to complete survey of Mt Nyiru owing to issues of accessibility, extreme heat and insecurity.

Further details on this survey are available in A.14.

9.5.7 COMPILATION OF SPATIAL DATA

Compilation of spatial data was led by BirdLife International. A wide range of data sources was reviewed to identify and incorporate relevant records. Data were added to a GIS database developed and managed by BirdLife. The final dataset included new data generated from gap-filling vulture tagging, and field surveys at priority sites for birds and bats. Table 9-3 summarises the site and species VEC data included, and their sources.

Table 9-3. Types, number and sources of VEC data included in the GIS database

Data	Type	Source	Number of polygons or locations	Notes
Key Biodiversity Areas (including Important Bird and Biodiversity Areas)	Site	BirdLife World Bird and Biodiversity Database	68	
Kenya wetlands	Site	Kenya Wetlands Database - National Museums of Kenya	1,226	
Kenya Protected Areas	Site	World Database on Protected Areas – UNEP-WCMC	269	
Key vulture colonies (nest and roost sites)	Site and species	The Peregrine Fund	21	Includes additional sites identified during field surveys
Key bat colonies (nest and roost sites)	Site and species	Kenya Bat Conservation Network /Paul Webala	42	Includes additional sites identified during field surveys
Topographic data - cliffs and ridges >=14.5°	Site	Shuttle Radar Topography Mission 90 m	2,840 pentad grid cells	
Presence and counts of VEC species at sites	Site and species	Various, including International Waterbird Census - National Museums of Kenya and BirdLife World Bird and Biodiversity Database	49 species at 77 wetland sites	
Observer records of birds of prey VECs	Species	African Raptor Databank	c. 20,000 species records at 11,768 observation points	http://www.habitatinfo.com/african-raptor-databank/

Observer records of other bird species VECs	Species	Kenya Bird Map Project (Nature Kenya)	127,00 records received, 4,434 VEC species records extracted	http://kenyamap.adu.org.za/
Observer records of other bird species VECs	Species	Kenya Birdfinder Project (Nature Kenya)	40,000 records received, VEC species extracted	The Kenya Birdfinder project, now closed, was a predecessor to Kenya Bird Map
Observer and specimen records of bird and bat VECs	Species	Kenya Bat Network, Global Biodiversity Information Facility (GBIF), eBird		GBIF is particularly useful for museum specimen records, and one of the few additional sources for bat locality data in Kenya
Area of Habitat maps (bird VECs)	Species	BirdLife International	106 species maps	Modelled maps that show areas of suitable habitat within a species' mapped range
Tracks of project-tagged and other tagged vultures	Species	The Peregrine Fund, North Carolina Zoo, University of Utah	Tracks for 76 vultures of five species	Analysis of time spent per pentad carried out by Rob Davies/Habitat Info

9.5.7.1 KEY BIODIVERSITY AREAS

Key Biodiversity Areas are places that are particularly important for the persistence of global biodiversity. In Kenya, to date most KBAs have been identified through BirdLife's Important Bird and Biodiversity Areas (IBAs) programme (Figure 9-4). IBAs are a set of sites of international significance for birds that are identified using a standardised set of data-driven criteria and thresholds, based on threat and irreplaceability. Lists of 'trigger' species and associated thresholds have been developed, and IBA qualification requires the confirmed presence of one or more populations or sets of species that meet these thresholds. As well as population information on relevant trigger species, BirdLife also maintains data on other significant bird populations within IBAs. The IBA dataset thus contributes information on both site and species VECs.

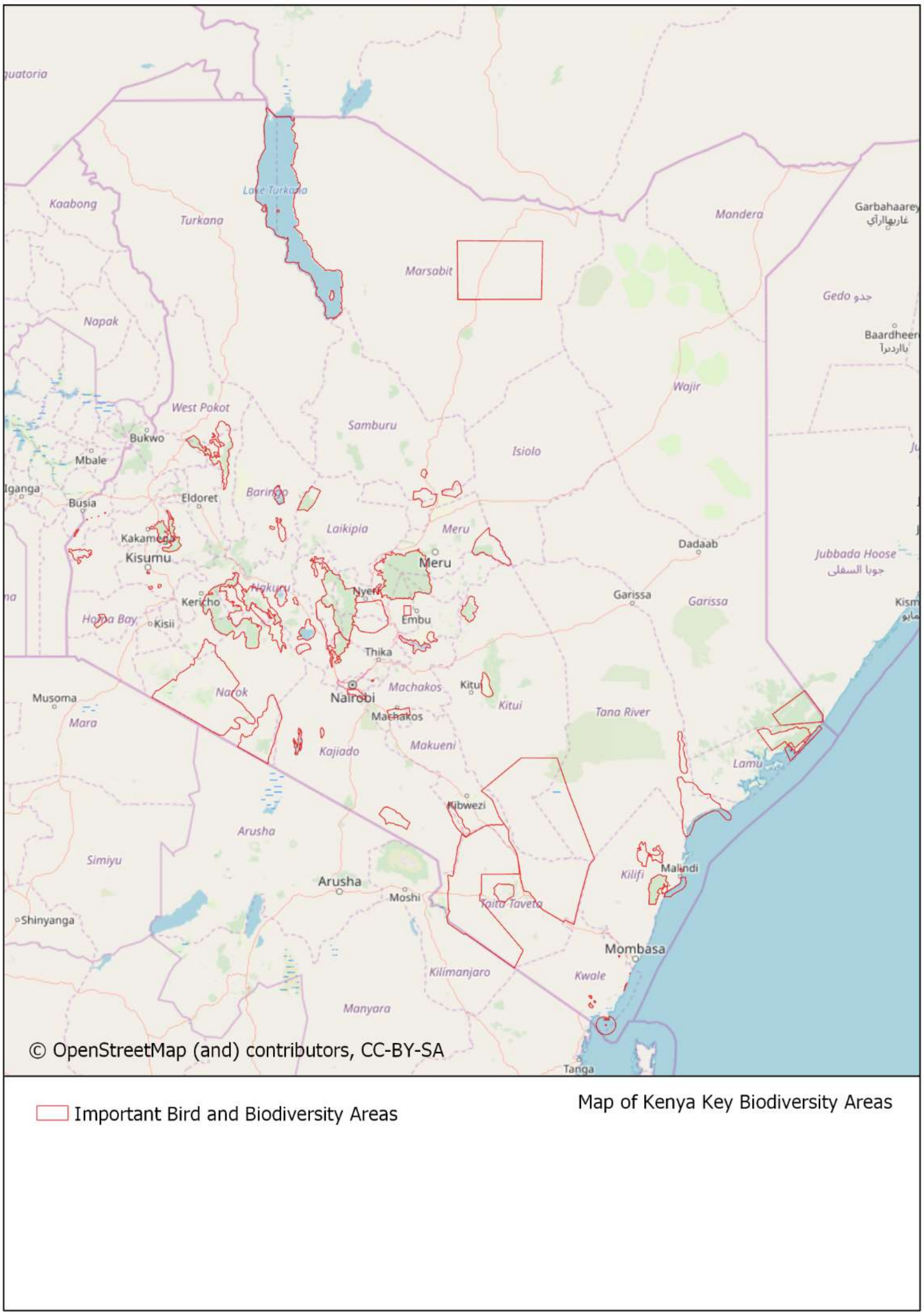

Figure 9-4 Site VECs in Kenya: Important Bird and Biodiversity Areas (a component of Key Biodiversity Areas)

9.5.7.2 PROTECTED AREAS

Kenya's protected areas were mapped using information in the World Database of Protected Areas (WDPA:Figure 9-5): a joint venture of UNEP and IUCN, produced by UNEP-WCMC and the IUCN World Commission on Protected Areas (IUCN-WCPA) working with governments and collaborating NGOs. The WDPA is compiled from multiple local and national sources and is the most comprehensive global dataset available on marine and terrestrial protected areas available.

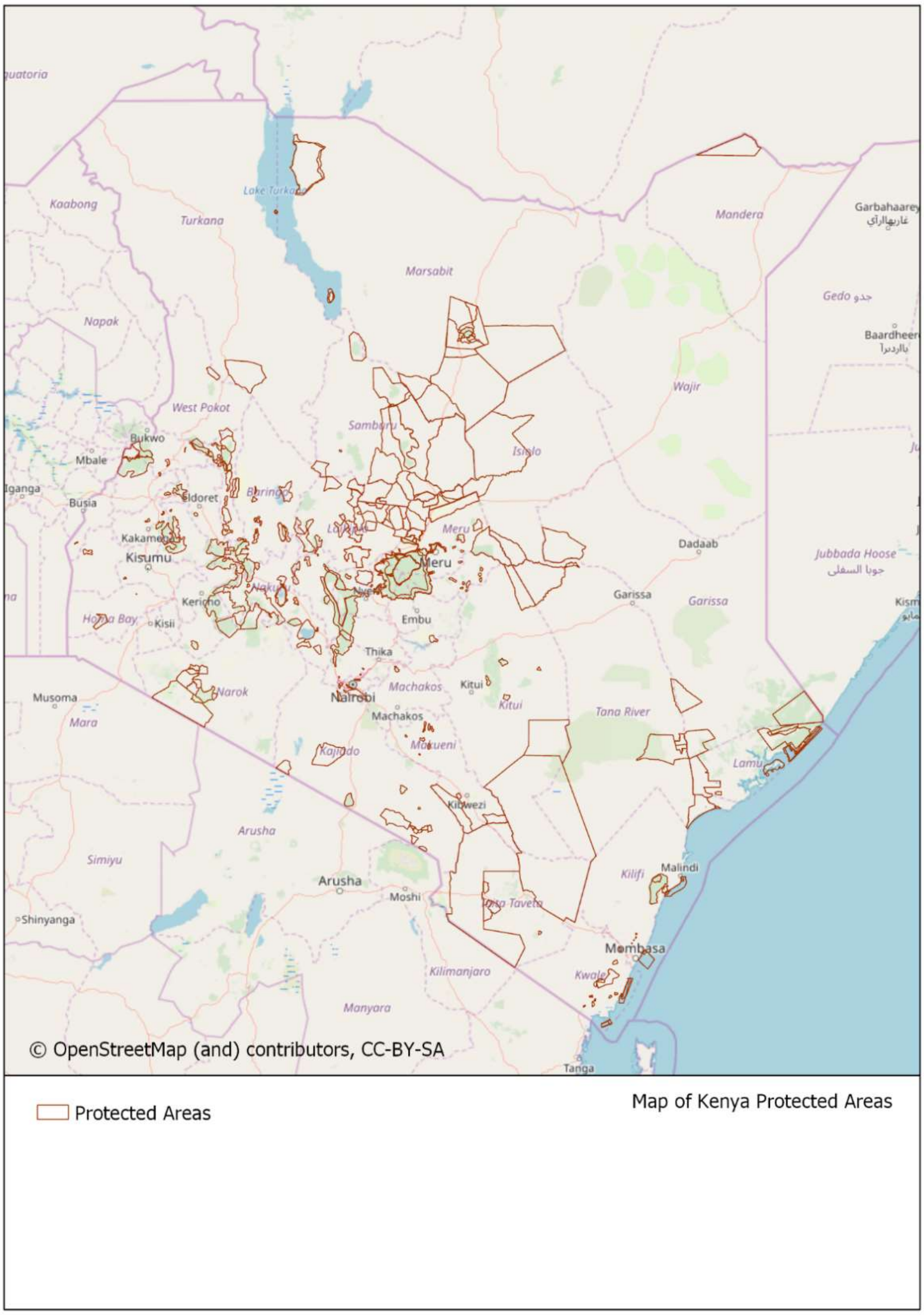

Figure 9-5 Site VECs in Kenya: Protected Areas

9.5.7.3 WETLANDS

Over 1,200 wetlands were mapped from the Kenya wetlands inventory maintained by the National Museums of Kenya (Figure 9-6). Species counts are available for a subset of sites (notably the larger ones, including Rift Valley lakes). Data were compiled from 20 years of waterbird counts to extract maximum counts of VEC species at each counted site – see below.

Wetlands were tagged by type based on a standard IUCN habitat classification.

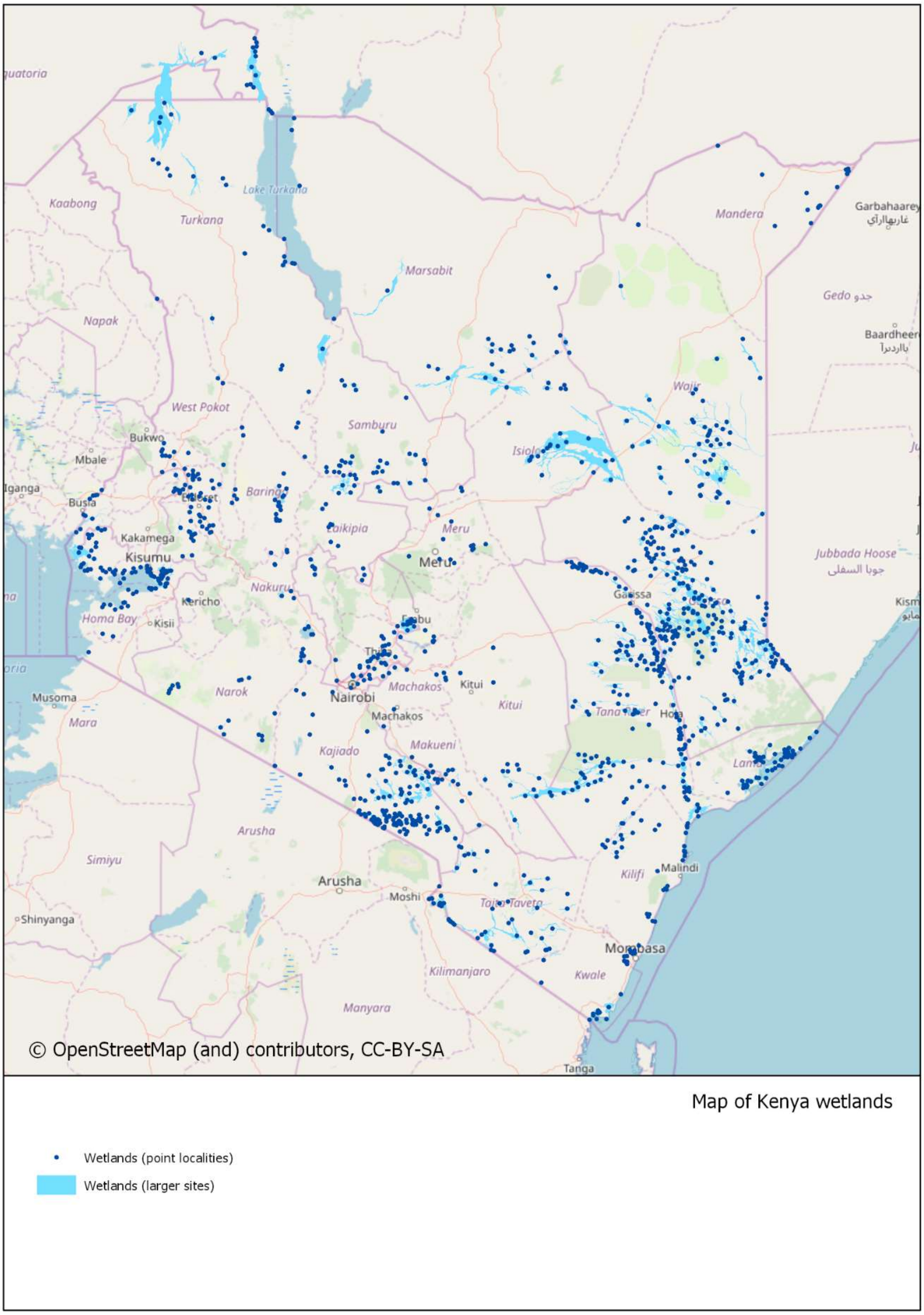

Figure 9-6. Site VECs in Kenya: Wetlands.

9.5.7.4 VULTURE AND BAT COLONIES

Some vulture species nest colonially or semi-colonially, on cliffs (e.g. Rüppell's Vulture) or trees (e.g. White-backed Vulture). Mapping these sites is crucial to the SEA, as vultures are in the highest risk category for wind power impacts – because of their flight behaviour, and because of rapid population declines that threaten them with extinction. Proximity of vulture nest sites to a potential wind power development is an indication of high biodiversity risk.

The Peregrine Fund has carried out extensive recent surveys of vulture nest and roost sites, and these are mapped within the SEA GIS database (

Figure 9-7). Most of the nests recorded are for Rüppell's and White-backed Vultures. White-backed Vultures nest in loose colonies in trees, which are more diffuse, less stable and less well documented than the cliff nesting sites for Rüppell's Vulture. Other tree-nesting vulture species include Lappet-faced Vulture and White-headed Vultures. We have clustered tree-nesting vulture nest locations at the pentad level in

Figure 9-7.

Similarly, key bat colonies were identified and mapped (Figure 9-8) based on surveys conducted by members of the Kenya Bat Working Group, and gap-filling surveys conducted for this SEA (see section 9.5.5).

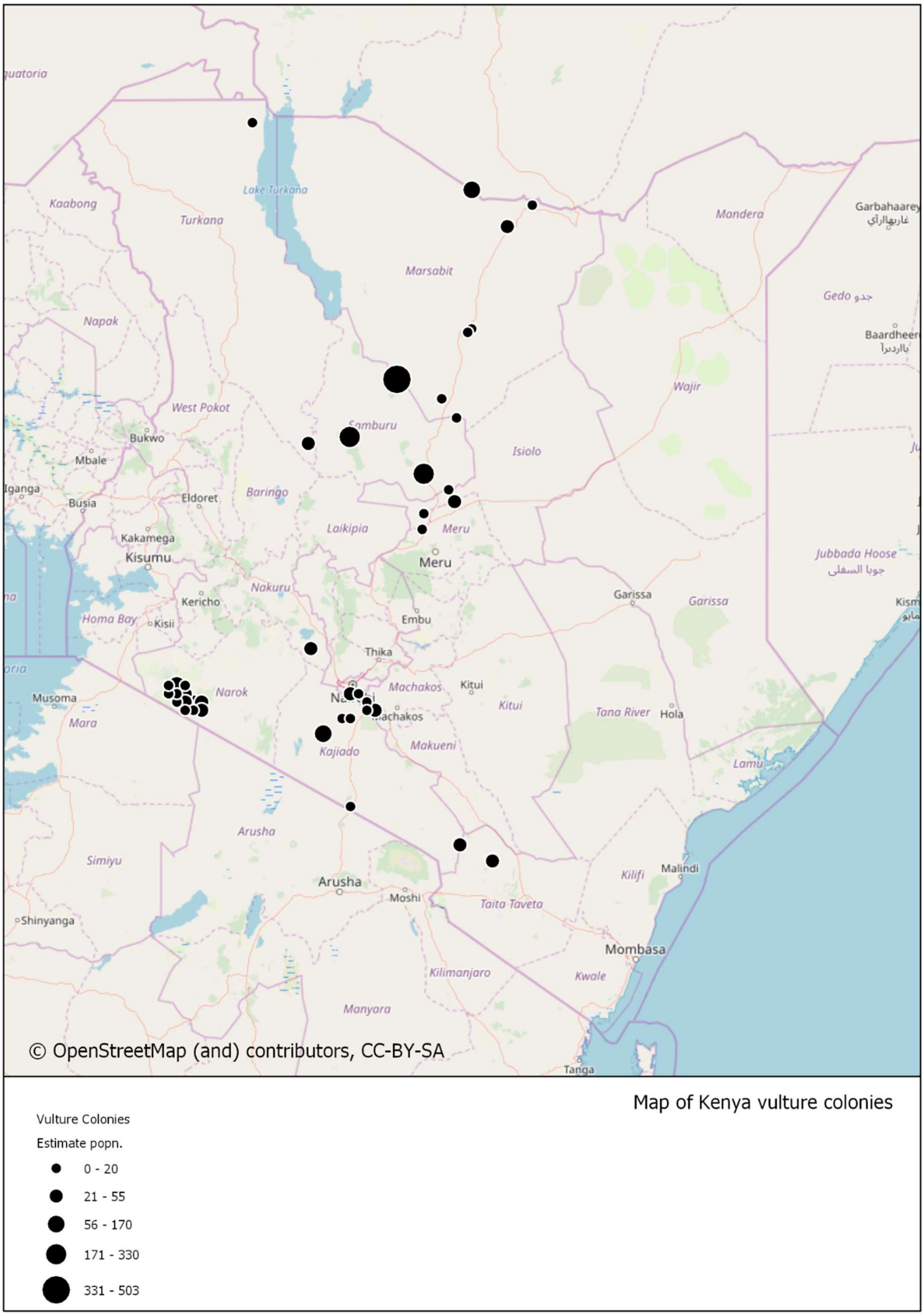

Figure 9-7. Known locations of vulture nesting colonies in Kenya. Tree-nesting vulture nest locations have been clustered at pentad level.

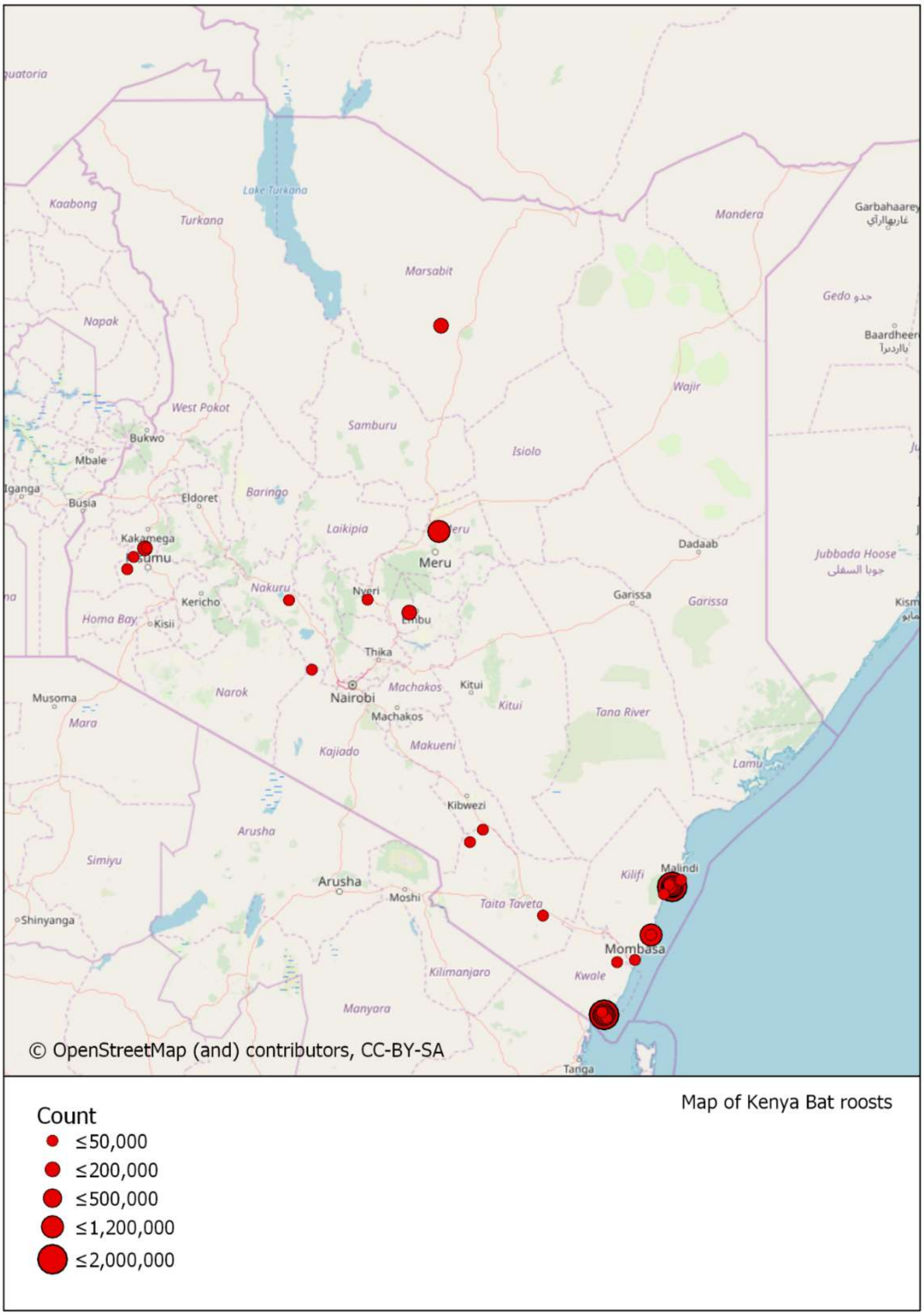

Figure 9-8. Known location of major bat roosts in Kenya

9.5.7.5 RIDGELINES AND SLOPES

Topography has been identified as a factor influencing the collision risk of obligate soaring birds with wind turbines. Ridgelines often generate updrafts that are used by soaring birds to maintain their flight.

BirdLife's sensitivity mapping for the Migratory Soaring Birds project includes a layer showing all ridgelines and slopes with an angle greater than 14.5°. Significant ridgelines and slopes were also mapped for Kenya (Figure 9-9) and incorporated into sensitivity scoring for VECs.

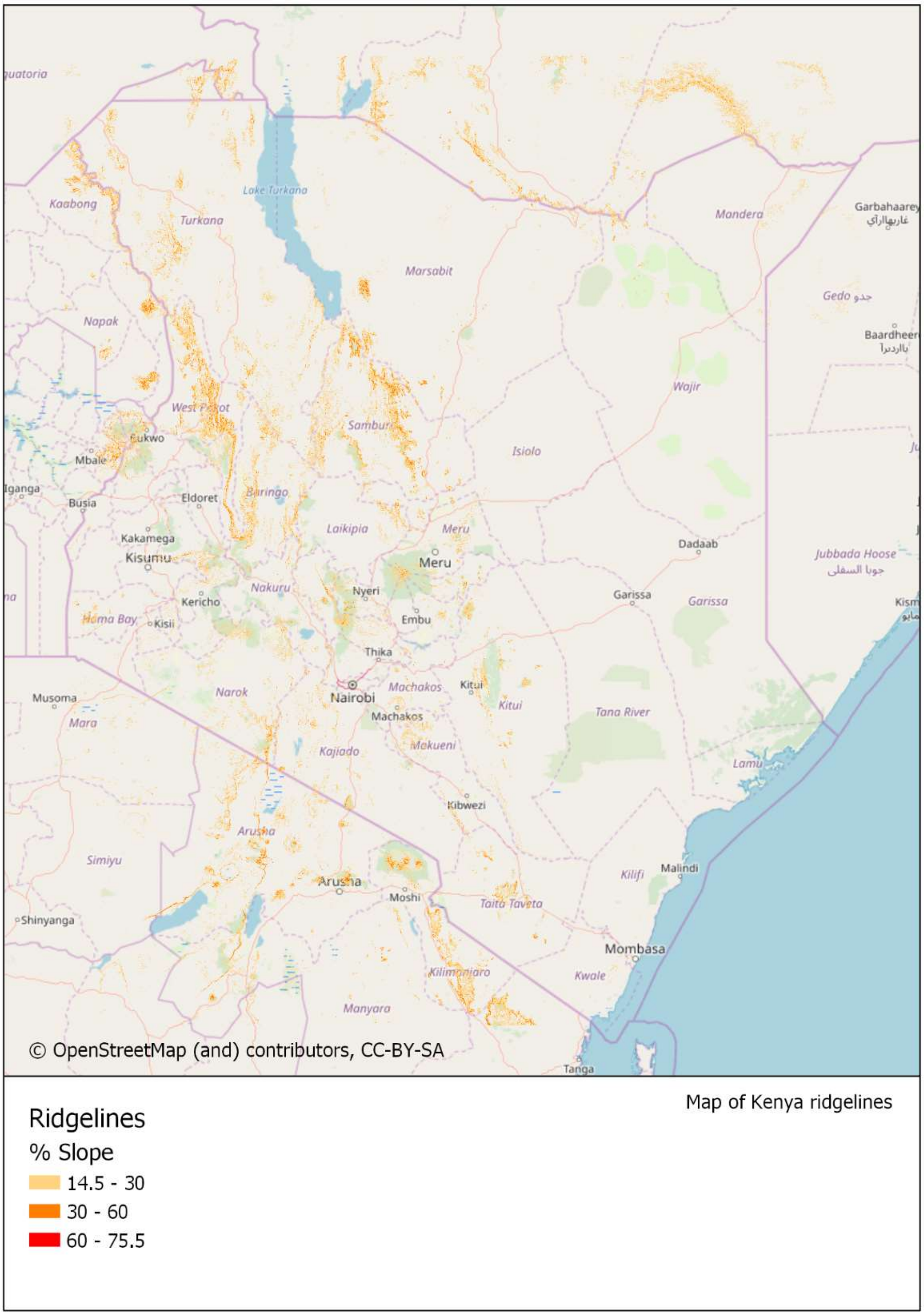

Figure 9-9. Ridgelines in Kenya with a slope greater than 14.5°, colour-coded to indicate the steepness of the incline.

9.5.7.6 OTHER SPECIES RECORDS

The final dataset incorporates thousands of georeferenced records on the distribution of VEC species. In addition to the site-referenced records mentioned above, the project compiled geo-referenced locality records for bird species VECs based on birdwatchers' observations from two major citizen-science observation projects in Kenya, the ongoing Kenya Bird Map and its predecessor, Kenya BirdFinder. Further records were extracted from e-bird, a repository for birders' records, and from the Global Biodiversity Information Facility (GBIF). Under a data access agreement with the African Raptor Databank, around 20,000 observations of bird-of-prey species VECs at over 11,000 separate localities were extracted by Habitat Info and added to the database.

Figure 9-10 shows the locations of observations of bird species VECs from these sources. It is well known that there are significant biases in the spatial distribution of such records, as birdwatchers tend to visit sites that are relatively accessible, or well-known as locations for particular species. Raptor counts have also often been carried out along roads. These spatial biases are evident in Figure 9-10 and need to be taken into account when analysing and interpreting this dataset.

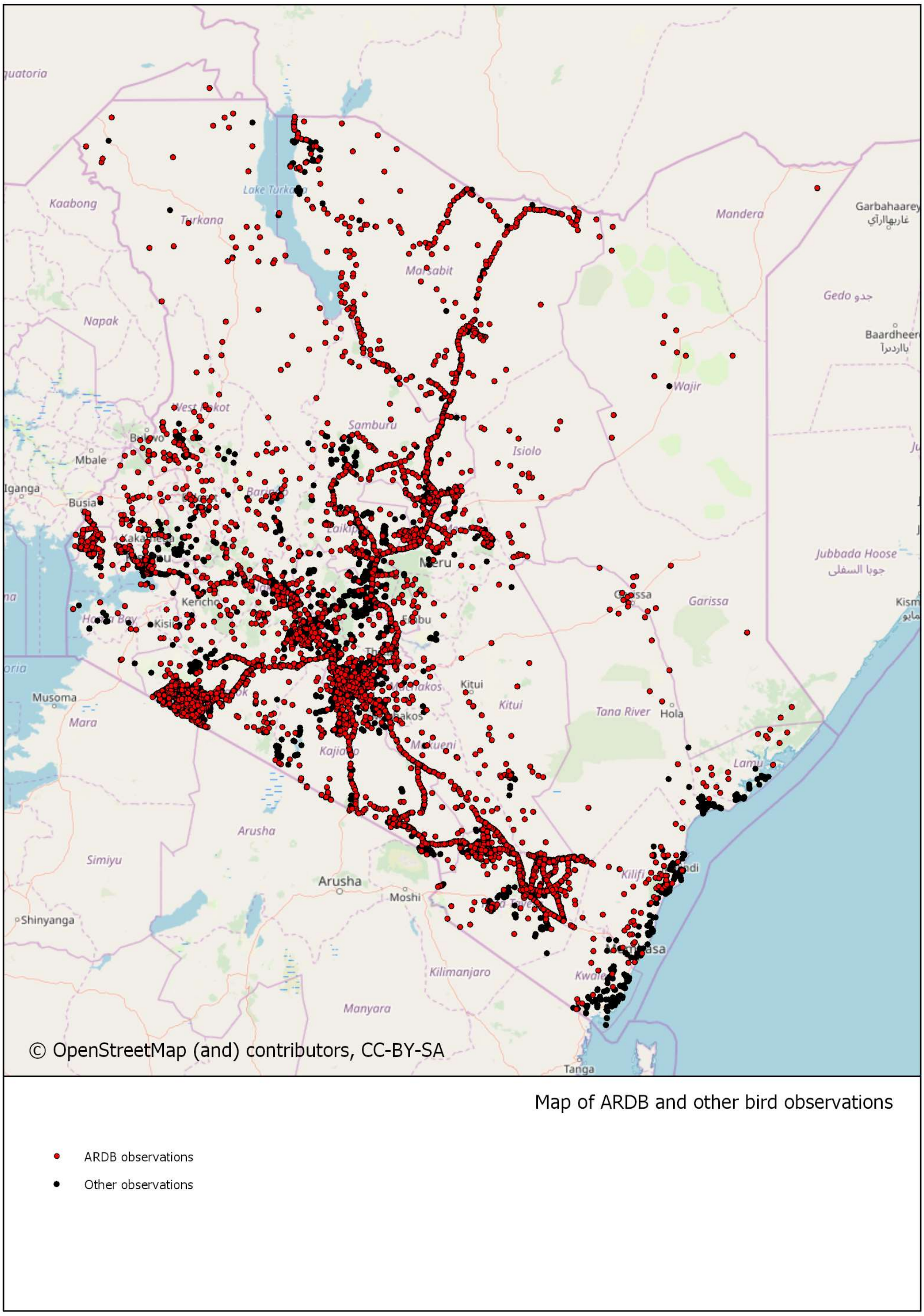

Figure 9-10. **Observation location records included in the SEA GIS database for raptor species VECs (from the African Raptor Databank) and for other VEC bird species.**

Observations of bats were mapped based on based on surveys conducted by members of the Kenya Bat Working Group, gap-filling surveys conducted for this SEA (see section 8.6.4), and records in GBIF (Figure 9-11).

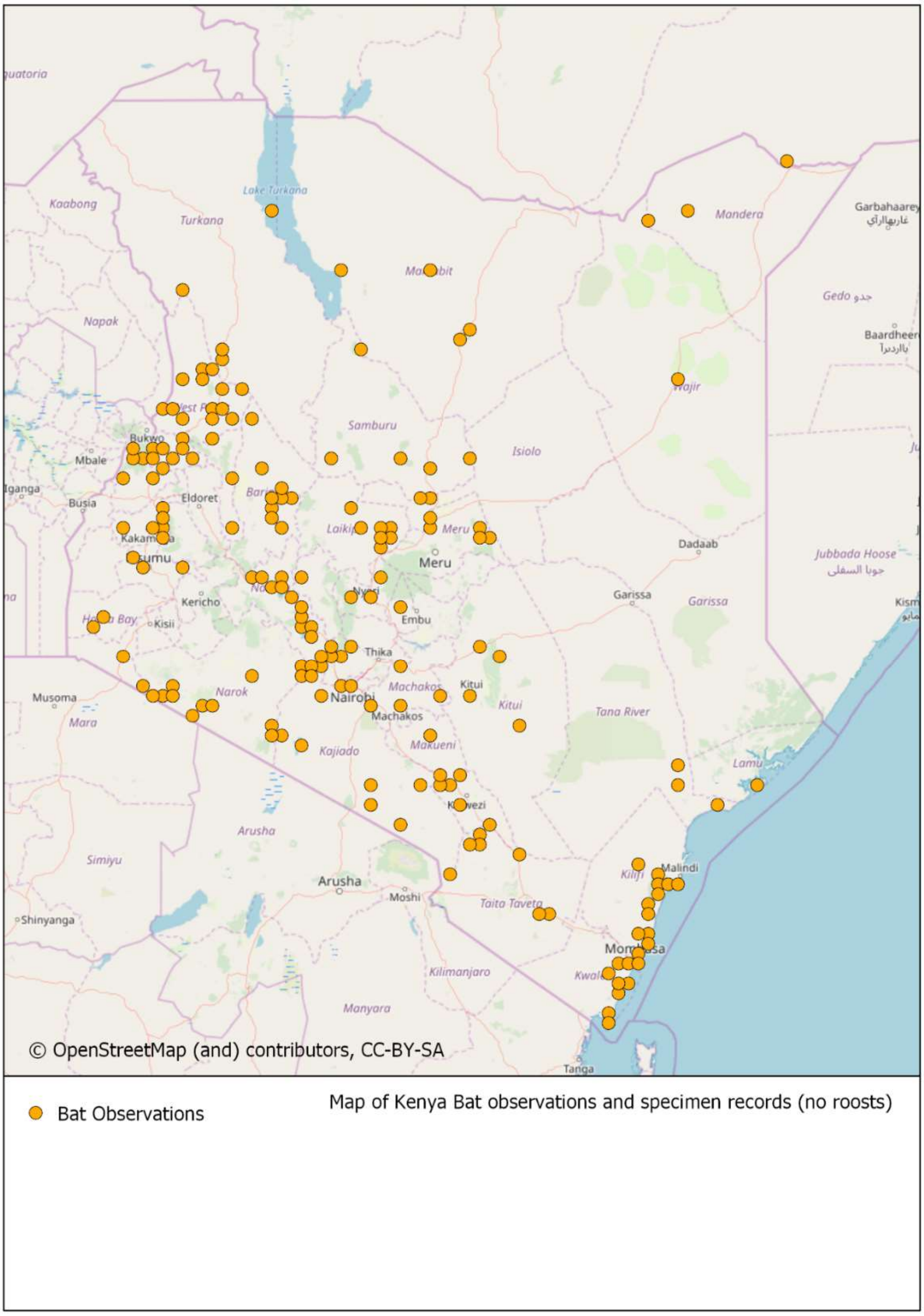

Figure 9-11. **Observation location records included in the SEA GIS database for bat species VECs (from the Kenya Bat Working Group, bat species surveys and GBIF.**

9.5.7.7 AREA OF HABITAT MAPS

BirdLife compiles and maintains digitized distribution maps for all of the world's bird species. Maps for VEC bird species will be utilized in the spatial analysis. The broad-brush distribution maps, while useful, are only a crude predictor of presence. Especially for wide-ranging and migratory species, including a number of VECs, these maps may provide little discrimination within the national boundaries (e.g. Figure 9-12a). We therefore analysed 'Area of Habitat' maps instead (e.g. Figure 9-12b). These are based on models that combine information on altitudinal and habitat preference with topographic and land-cover maps to create more accurate predictors of distribution.

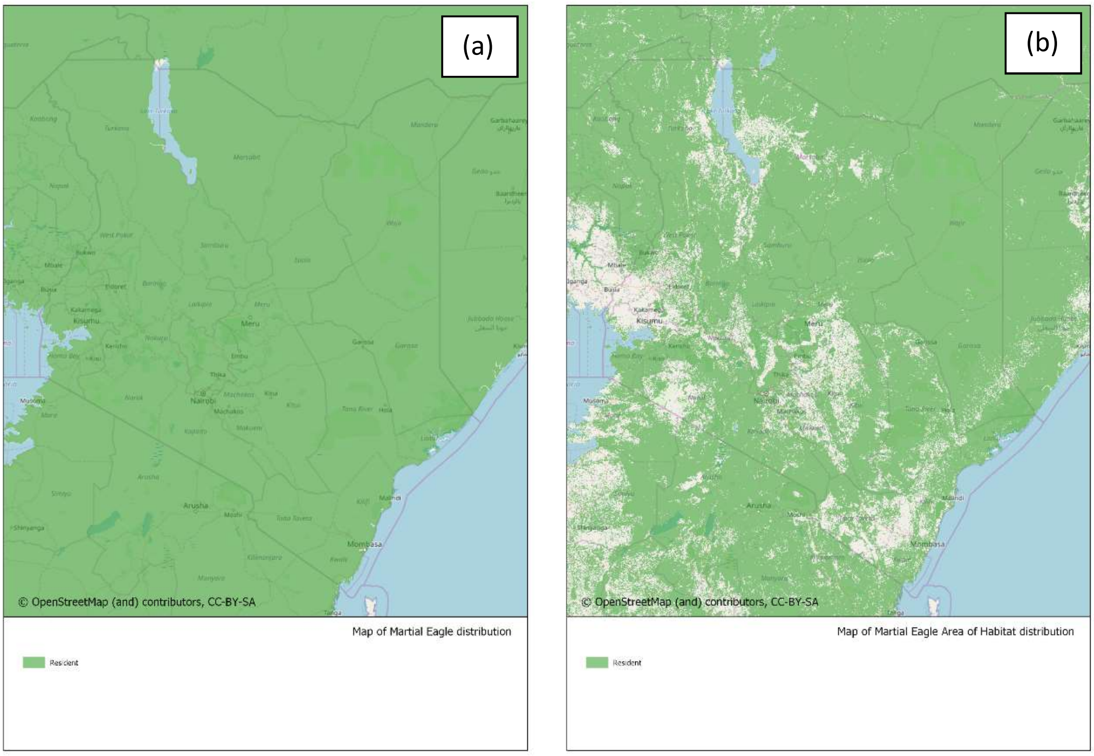

Figure 9-12. Example range map (a) for the very wide-ranging Martial Eagle *Polemaetus bellicosus* compared to the modelled Area of Habitat map (b) for this species.

9.5.7.8 SPECIES RECORDS AND COUNTS AT SITES

Where available, the information for site VECs includes maximum counts of species VECs at those sites. This is important to ensure compatibility with the BirdLife Sensitivity Mapping Tool for wind power, which uses these counts to develop sensitivity scores.

There are few counts in Kenya of migratory birds on passage. Most site-based counts are of waterbirds through the International Waterbird Census. A number of Kenya's most important wetland sites, and many more minor ones, are counted (usually) twice a year, in January and in June. These data are held by the National Museums of Kenya but unfortunately not compiled electronically in a single, accessible database. We extracted count data for waterbird VECs from the published count reports available for the years 1998-2010, while the National Museums of Kenya Ornithology Section compiled the remaining, unpublished data for the years 2011-2018.

The presence of VEC species at VEC sites was established via the species record information, and also where relevant from species lists in the BirdLife Key Biodiversity Areas database, published checklists and other sources.

9.5.7.9 VULTURE TRACKING DATA

Thanks to the generosity of the data holders (see Table 9-3 and Acknowledgements), we were able to compile movement data from 76 tagged birds, including the vultures tagged specifically for this assessment (see section 8.6.3). These birds were tagged in a number of different locations, corresponding to the key concentrations of nesting and foraging vultures in the country. The movements of tagged birds collectively thus now give a fairly complete picture of where vultures are spending time across the country as a whole (Figure 9-13). The birds tagged with support of this SEA in Marsabit County are key in filling in this picture for northern Kenya There are likely to be some gaps remaining – for instance, coastal Kenya has very few tracks, whereas concentrations of White-backed Vultures have been seen recently in the Tana River Delta and are recorded along the coastal strip from the Tana delta to Somalia (F. Ng'weno, in litt.)

Table 9-4. Tagged vultures with tracks available for analysis, by species

Species	Number tagged
Egyptian Vulture	1
Hooded Vulture	3
Lappet-faced Vulture	12
Rüppell's Vulture	23
White-backed Vulture	37
Total	**76**

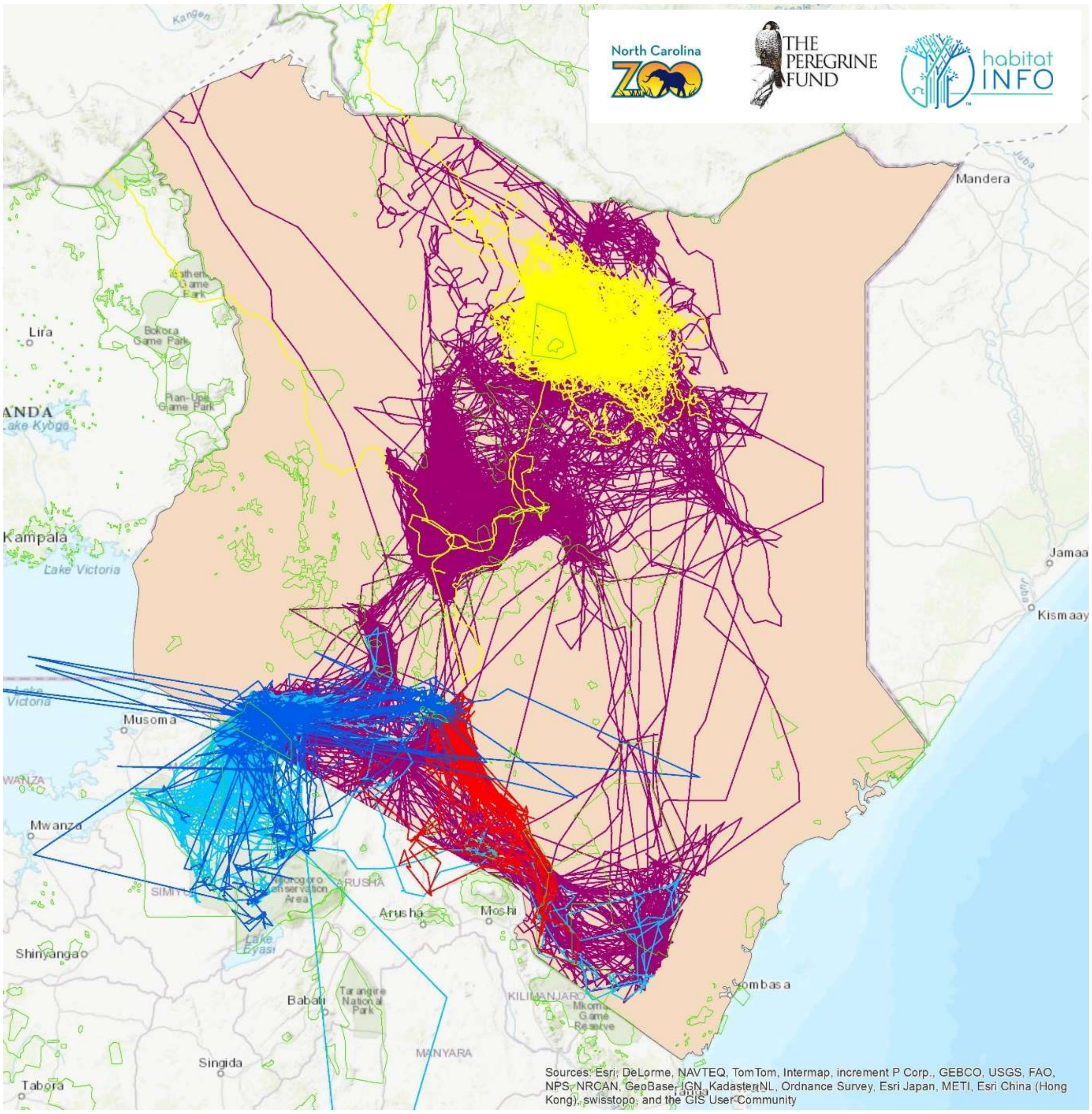

Figure 9-13. Movement data from tagged Kenya vultures available for analysis. Purple: pre-2018 tags (Corinne Kendall/North Carolina Zoo and Munir Virani/The Peregrine Fund: Narok County; Darcy Ogada/The Peregrine Fund: Laikipia and Marsabit Counties; Evan Buechley/University of Utah: Ethiopia); yellow: Darcy Ogada/The Peregrine Fund (Marsabit County); light blue (since April 2018) and dark blue (Argos, pre-April 2018): Munir Virani/The Peregrine Fund (Narok County); red: Munir Virani (GPS data, Kajiado County).

9.5.7.10 VECS NOT INCLUDED IN SPATIAL DATABASE

Not all proposed VECs could be included in the GIS database for sensitivity mapping. The expert workshop identified a number of migratory corridors in the country, including a Somali-Maasai biome corridor from Meru NP through Tsavo; around Lake Victoria shoreline; Timau (stopover site for raptors and storks), a coastal corridor including Tana River delta and Mida Creek for waterbirds, and Tana River delta through Tsavo East NP for landbirds; and the Rift Valley from Magadi to Turkana for flamingos and other species. However, there was not enough information to allow delineation of these routes and the particular VEC species that use them. This may be a focus for future research.

Similarly, we had intended to incorporate movement tracks of VEC species (in addition to vultures) that have been tagged by migration researchers. We investigated the availability of tracks from Movebank (http://www.movebank.org), an online database of animal tracking data hosted by the Max Planck Institute for Ornithology. However, tracks for only a few VEC species and individuals were available for Kenya, and these data were insufficiently comprehensive to inform the sensitivity mapping. Data use for most datasets was also restricted. These datasets are improving over time as more individual birds, and more species, are tagged, and may also be a focus for future research.

Figure 9-14, Figure 9-15 and Figure 9-16 illustrate movement patterns from satellite tagging for three migratory species, with quite different spatial patterns of movement. White Stork (Figure 9-14) shows a strong concentration in the highlands west of the Rift Valley, and to a lesser extent along the Rift and in the eastern highlands. Lesser Flamingo (Figure 9-15) shows movements along the string of alkaline lakes in the Rift Valley floor. Amur Falcon (Figure 9-16) has an unusual migration from east Asia through India and across the Indian Ocean to the East African coast. Its migration in Kenya is predominantly through the coastal lowlands and the low plateau east of the highlands.

The fact that a satellite-tracked bird moves over a pentad (or the location of a potential wind energy development) is not necessarily an indication of high collision risk. On their long-distance movements, migratory birds often fly at well above rotor-swept height. When birds descend to rest or feed, or under certain weather conditions, the risk of collision may be higher.

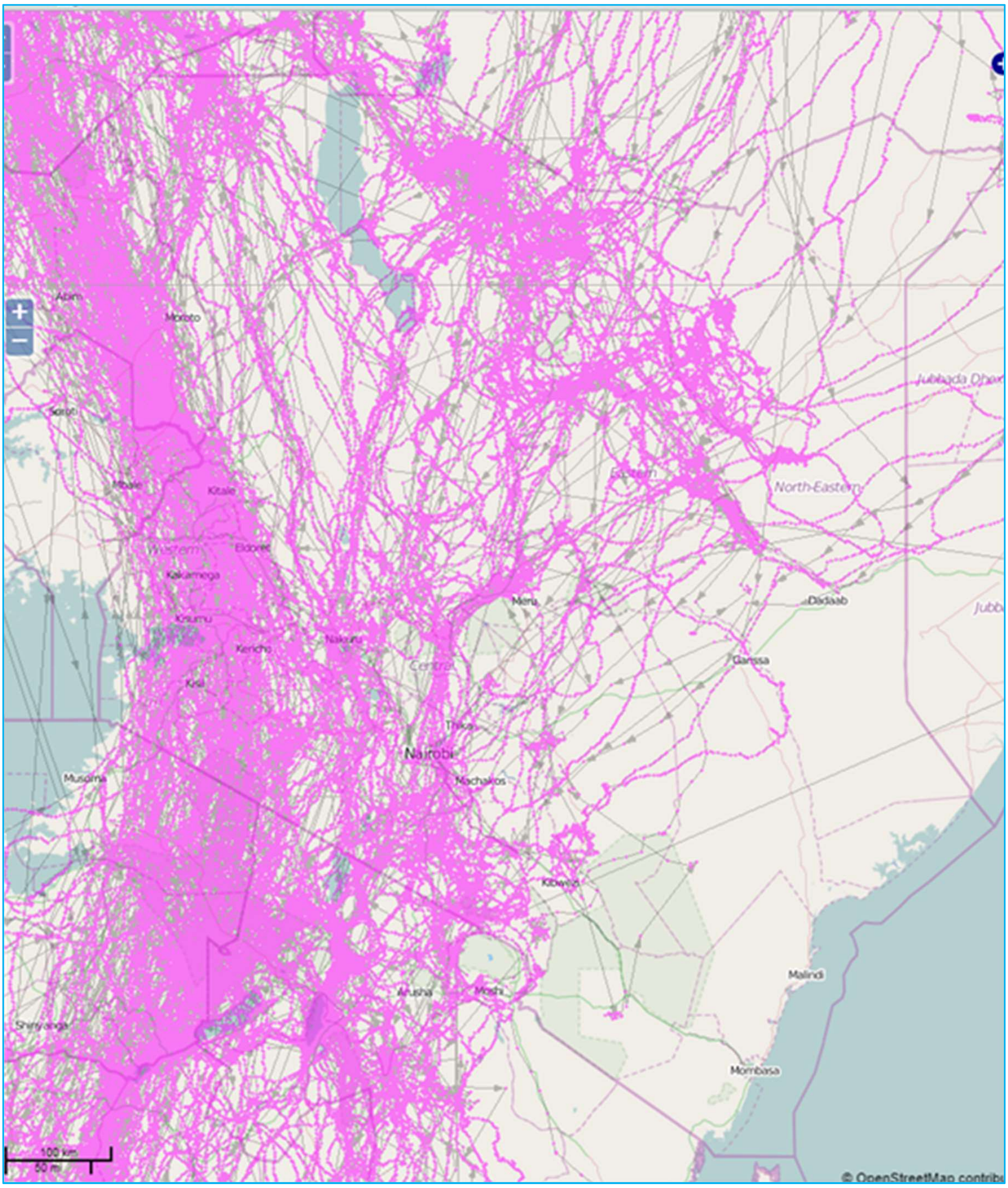

Figure 9-14. White Stork satellite tracks in Kenya, from the Movebank data repository

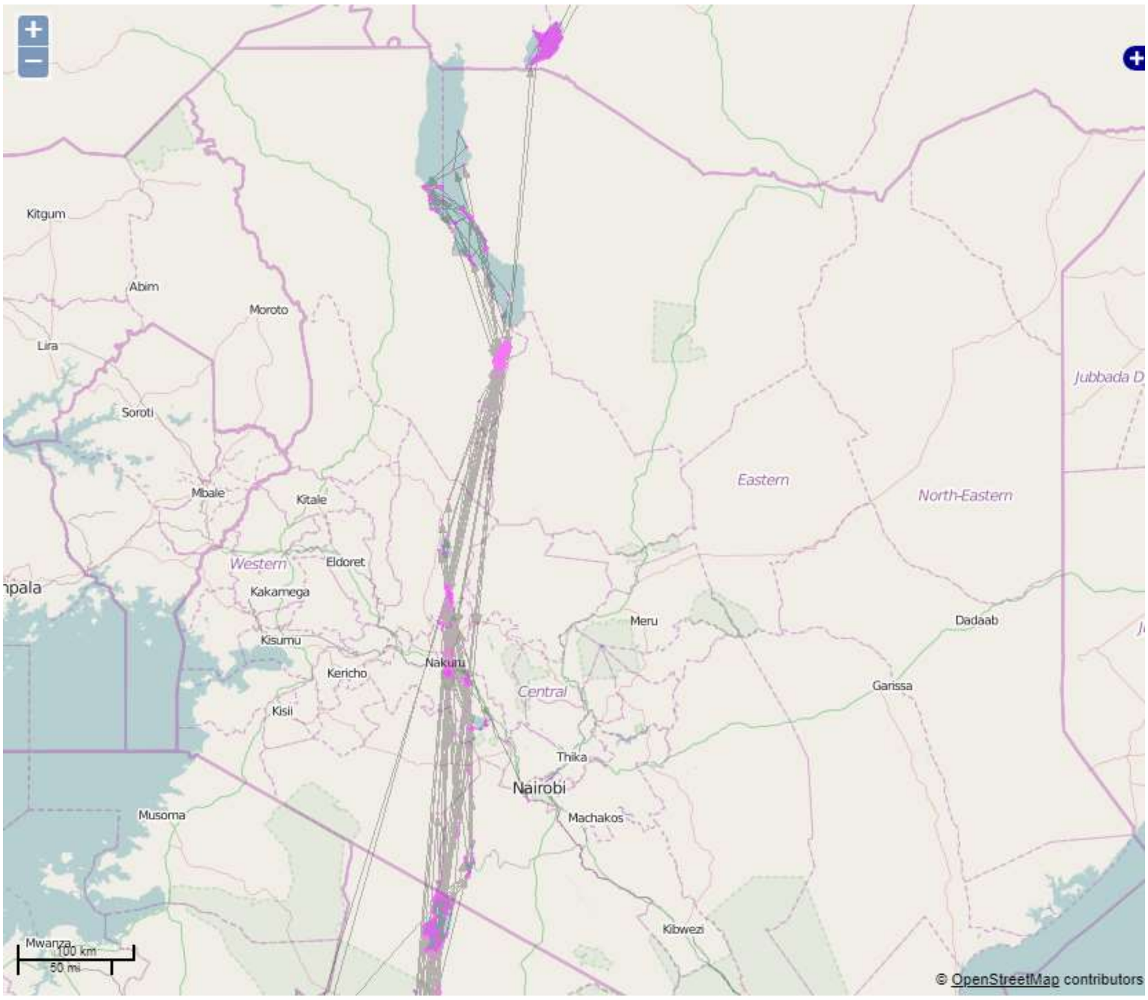

Figure 9-15. **Lesser Flamingo satellite tracks, from the Movebank repository**

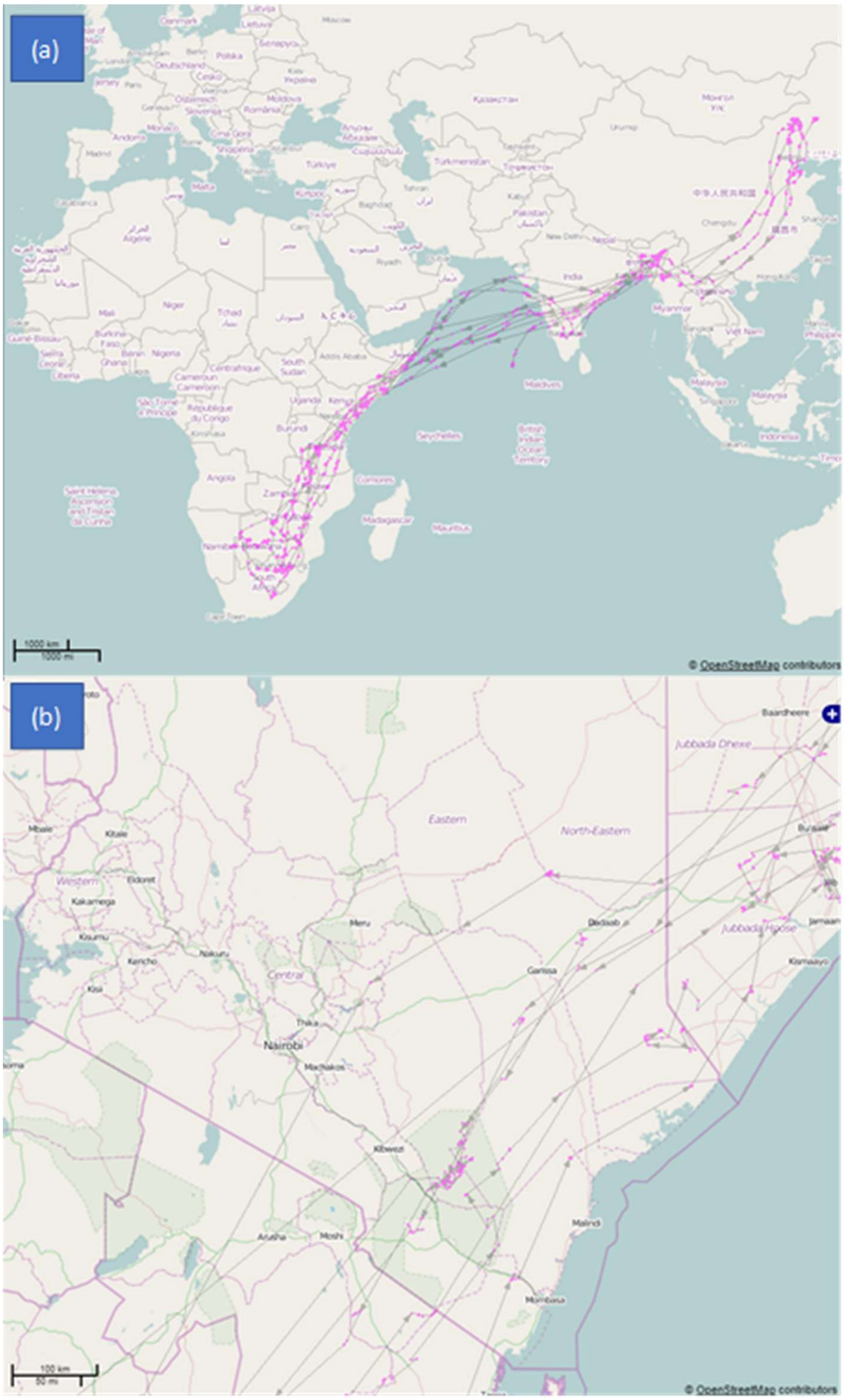

Figure 9-16. Amur Falcon tracks, from the Movebank data repository: (a) movements along the entire flyway, (b) movements in Kenya.

9.5.8 ANALYSIS OF SPATIAL DATA

9.5.8.1 MAPPING TO KENYA BIRD MAP PENTADS

For consistency with ongoing bird atlas efforts in Kenya, and ease of future information update, species and site locality data were mapped onto individual pentads used by the Kenya Bird Map project (Wachira et al. 2015; see http://kenyamap.adu.org.za/). Pentads are 5' x 5' squares within which bird map observations are recorded. There are 6,817 pentads covering Kenya, of which 1,000 had at least one full-protocol Kenya Bird Map checklist logged by the end of 2018 (Figure 9-17; S. Shema, in litt.). In Kenya, pentads cover an area of approximately 9 x 9 km (Wachira et al. 2015), which is a suitable scale for sensitivity mapping to inform potential wind energy development.

The current observer coverage of Kenya Bird Map pentads also illustrates the spatial variation in observer effort across the country.

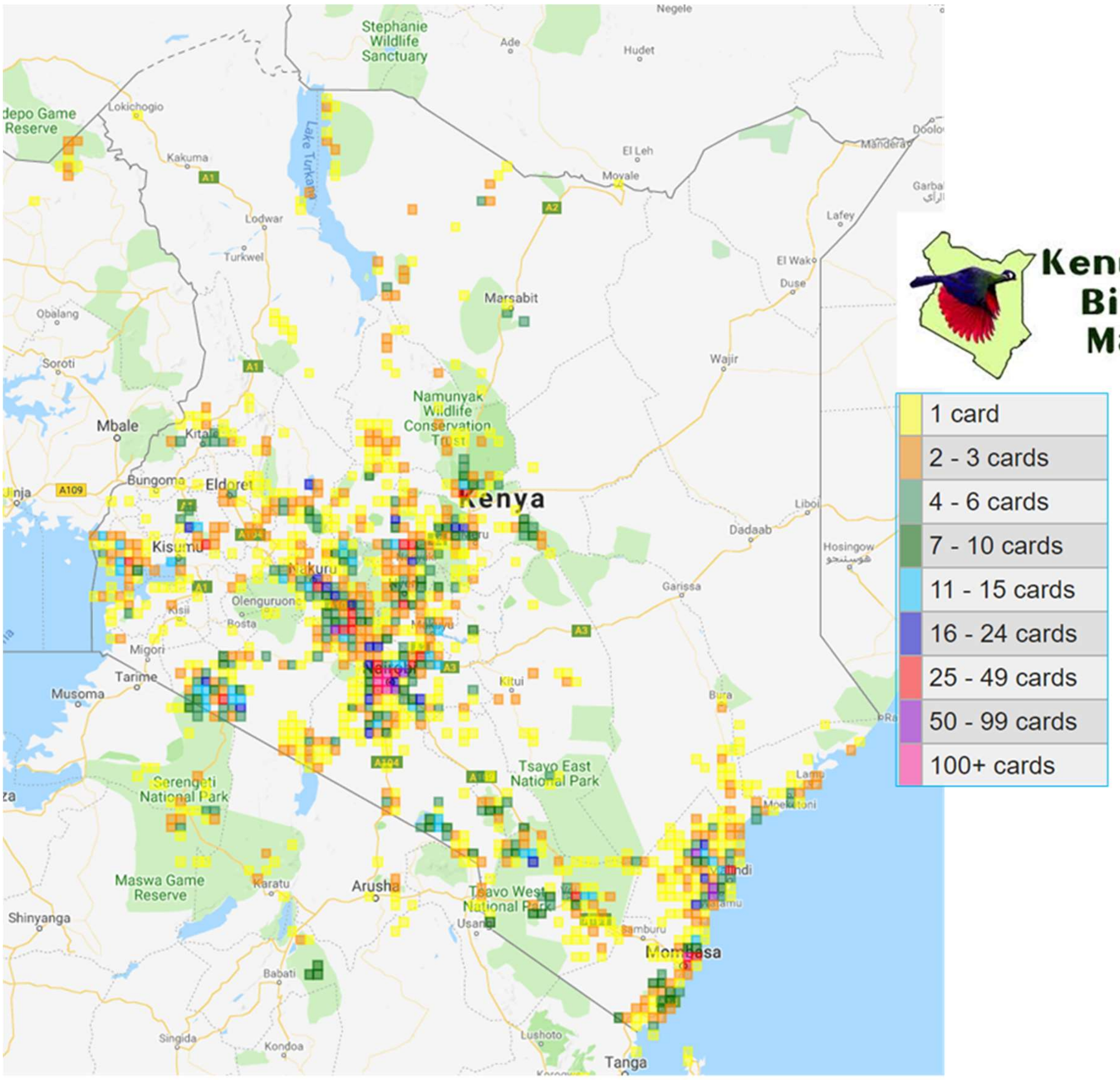

Figure 9-17. Coverage (number of full protocol checklists) of Kenya Bird Map pentads, February 2019 (from Kenya Bird Map website)

9.5.8.2 AREA OF HABITAT HEAT MAP

BirdLife's species range maps have been refined using information on elevation and habitat preference to create more accurate distributional maps called Area of Habitat (AoH) maps (see section X). The AoH maps for the avian VEC species were weighted in accordance with their sensitivity category (Table 8-4) and overlaid to create a heat map (Figure 9-18).

Species VECs show concentration in the centre and southern parts of Kenya, and more patchily along the Rift Valley and adjacent eastern highlands. Species VEC sensitivity based on AoH ranges is relatively low across the eastern half of the country, including at the Kenya coast.

Table 8-4. Vulnerability scores used in

Sensitivity Category	Weighting score
Very High	10
High	8
Medium	5
Low	2

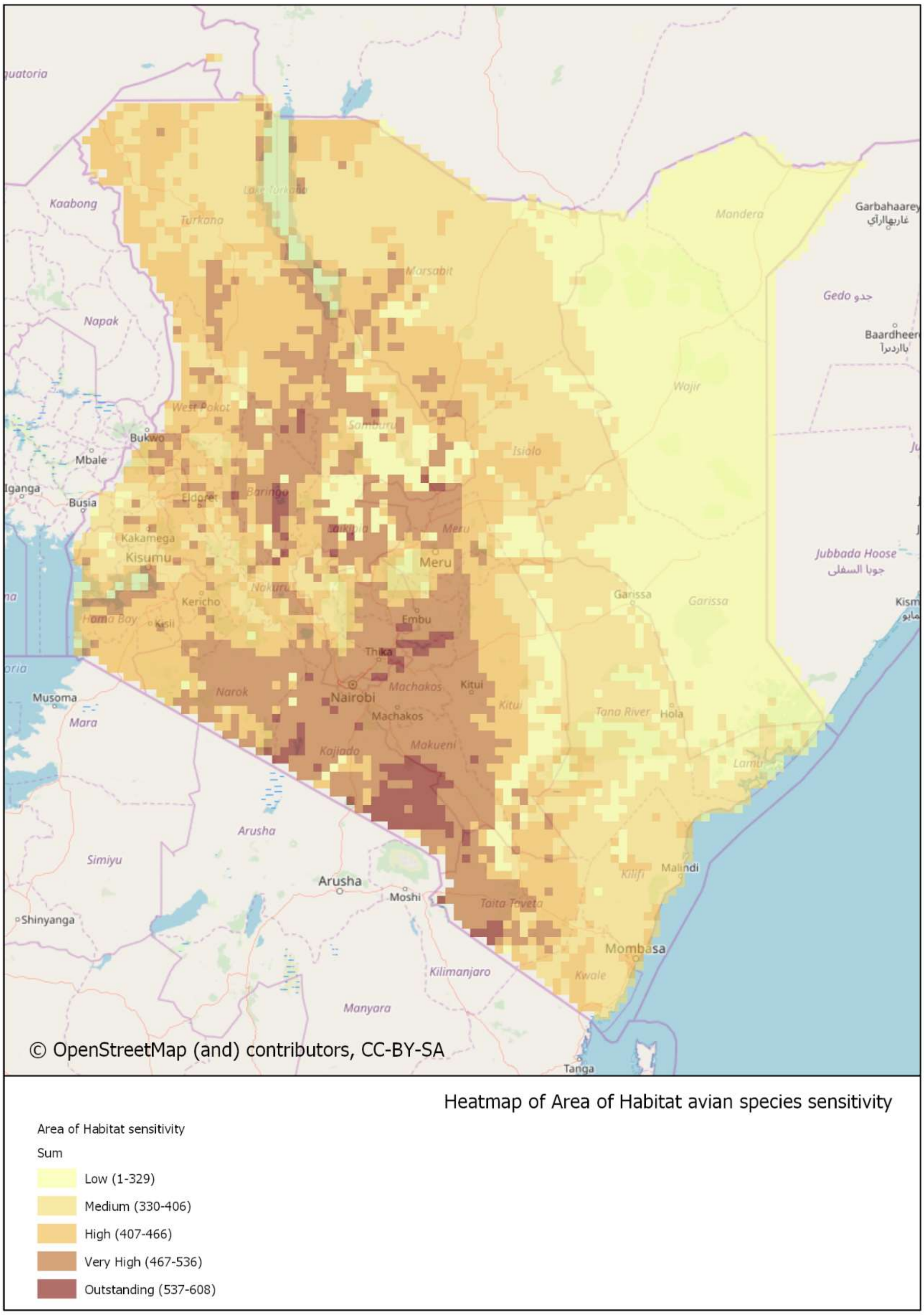

Figure 9-18. AoH heat map for avian VEC species, using weighted scores from Area of Habitat mapped to Kenya Bird Map pentads

9.5.8.3 SPECIES OBSERVATION HEATMAP

Thousands of georeferenced observation records of both bird and bat VEC species were collated from numerous sources (see Section 9.5.7.8). Each individual record was weighted in accordance with the species Vulnerability score (see above). Weighted records were then summed across each pentad.

We considered two other aspects for this mapping:

Approaches to categorization – we compared heatmaps using three categorization methods provided by ArcGIS: geometric, Jenks' natural breaks, and quantile. Geometric categorization appeared to give the most useful differentiation between categories, and was selected for the analysis.

Spatial variation in observation effort: recorder bias in this dataset is hard to control for. The South African Bird Atlas uses 'reporting rate' (the percentage of submitted atlas cards on which the species is recorded), which helps to control for inconsistent effort. This approach can eventually be used by Kenya BirdMap too, but there are insufficient submitted full protocols to make this reliable. Our observation records are also from numerous other sources too, making it difficult to correct in this fashion.

Another option would be to cap the number of records included per species per pentad, to avoid the very well-watched pentads swamping the rest. However, this loses information (in many cases, more records do relate to the species' real presence in the pentad), and it is difficult to decide on the 'right' cap.

We compared the effects of mapping the records in three ways (Figure 9-19):

A - all observation records

B - all records, but with no duplicate observations (duplicate records of the same species in the same locality removed)

C - all records, but with no duplicate species (duplicate records of the same species in the same pentad removed)

Of these three, we selected (B) (no duplicate observations) as the best compromise between reducing the effects of uneven observer effort, and losing useful data.

Species VEC sensitivity based on observations shows geographic patterns broadly similar to that based on Area of Habitat range maps, with elevated sensitivity concentrated in the central third of the country, and in southern Kenya. However, the coastal strip now also shows up as an area of elevated sensitivity, as do parts of western Kenya.

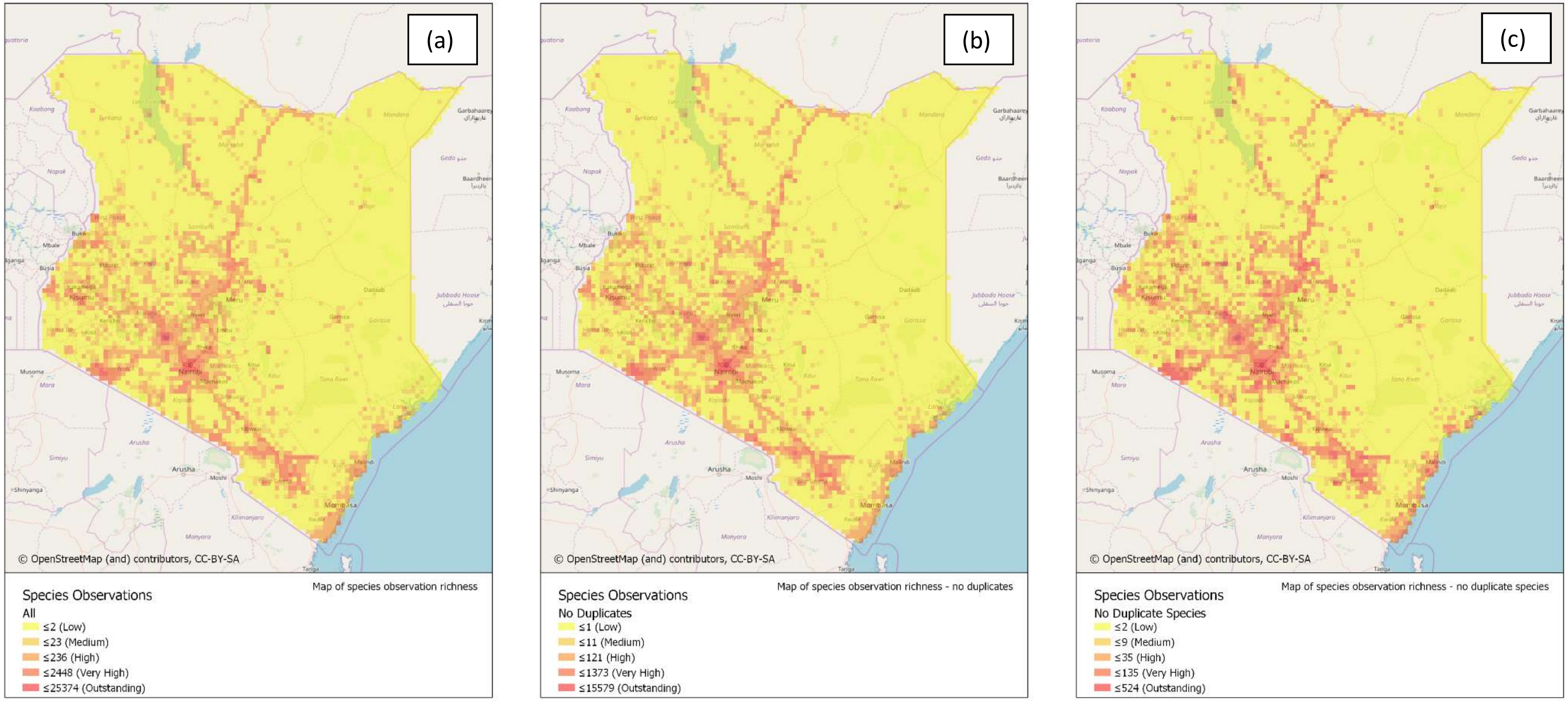

Figure 9-19. Bird VEC species richness (unweighted) mapped to Kenya Bird Map pentads from observation records, using a geometric categorisation and (a) all records, (b) any duplicate observations (same species, same locality) removed, (c) any duplicate species (same species, same pentad) removed.

9.5.8.4 VULTURE ACTIVITY HEATMAP

The tracking data from tagged vultures can be analysed in various ways. For comparison with other data layers, we needed a pentad-based analysis. The most useful parameters are either distance covered per pentad (an indication of flight activity) or the time spent per pentad (an indication of relative intensity of use, including foraging, roosting and nesting activity).

The tracking data show that vultures make extensive foraging movements, sometimes over long distances. Long-distance movements are often made well above rotor-swept height. Immature birds in particular are known to wander widely; two juvenile White-backed Vulture tagged in Marsabit County and Laikipia County had moved within three months to southern Ethiopia and the Sudan/Uganda border respectively. Thus, time spent per pentad is likely to be a more useful indication of vulture activity than distance travelled. Analysing time spent per pentad poses some technical challenges, as there are more than a million tracklog segments in this dataset for Kenya. To keep the analysis tractable, we used an approximation: rather than attempting to split track segments by pentad square, we summed values from the entire length of the segment. Although some track segments do extend beyond a pentad, resulting in an overestimate, most do not: the mean segment length is 713 m, less than 8% of the pentad side length (9300 m). For assigning the category scores used in our analysis, this accuracy is more than sufficient.

Figure 9-20 and Figure 9-21 show respectively distance travelled and time spent per pentad by tagged vultures.

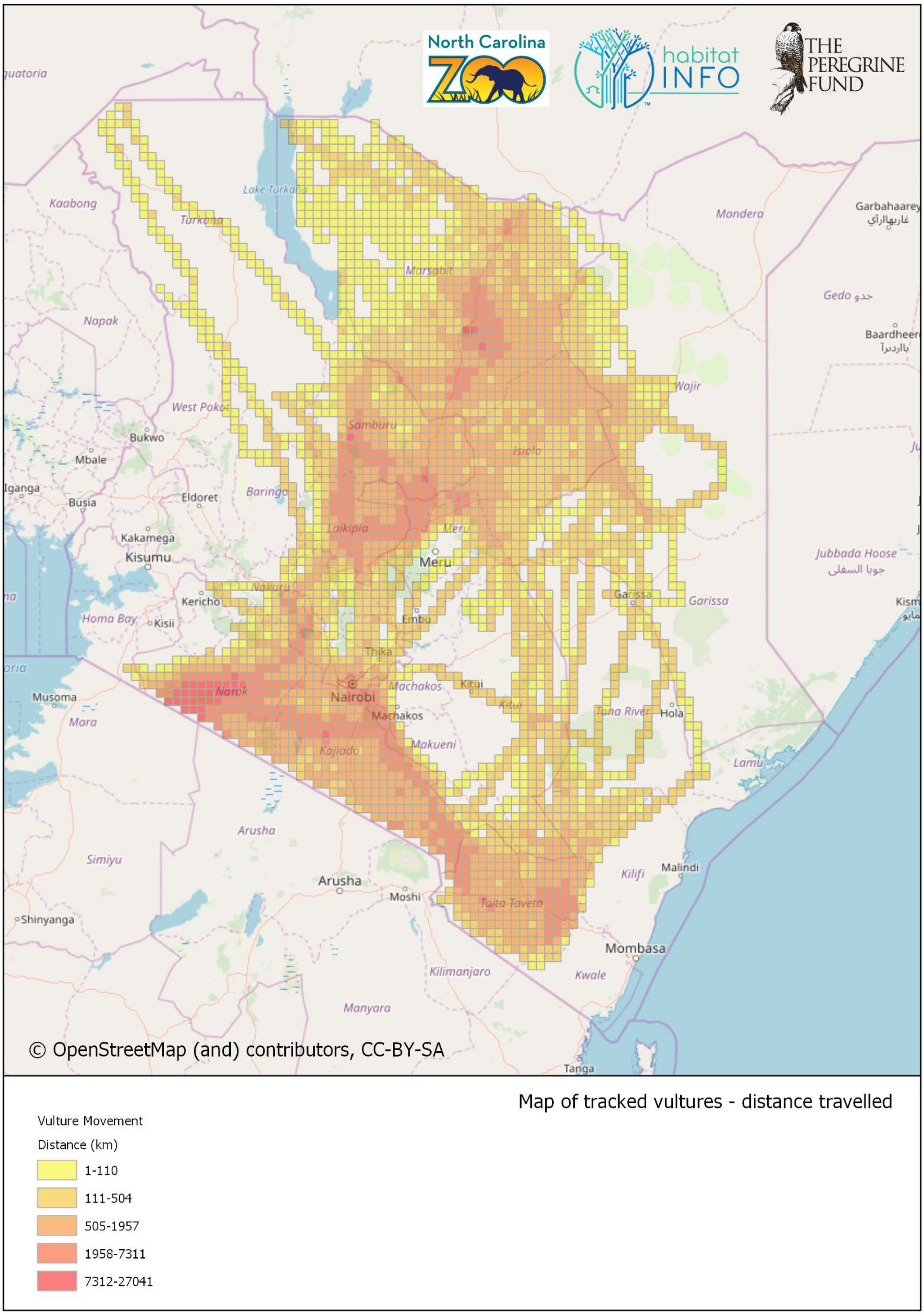

Figure 9-20. Distance travelled by tagged vultures mapped to Kenya Bird Map pentads

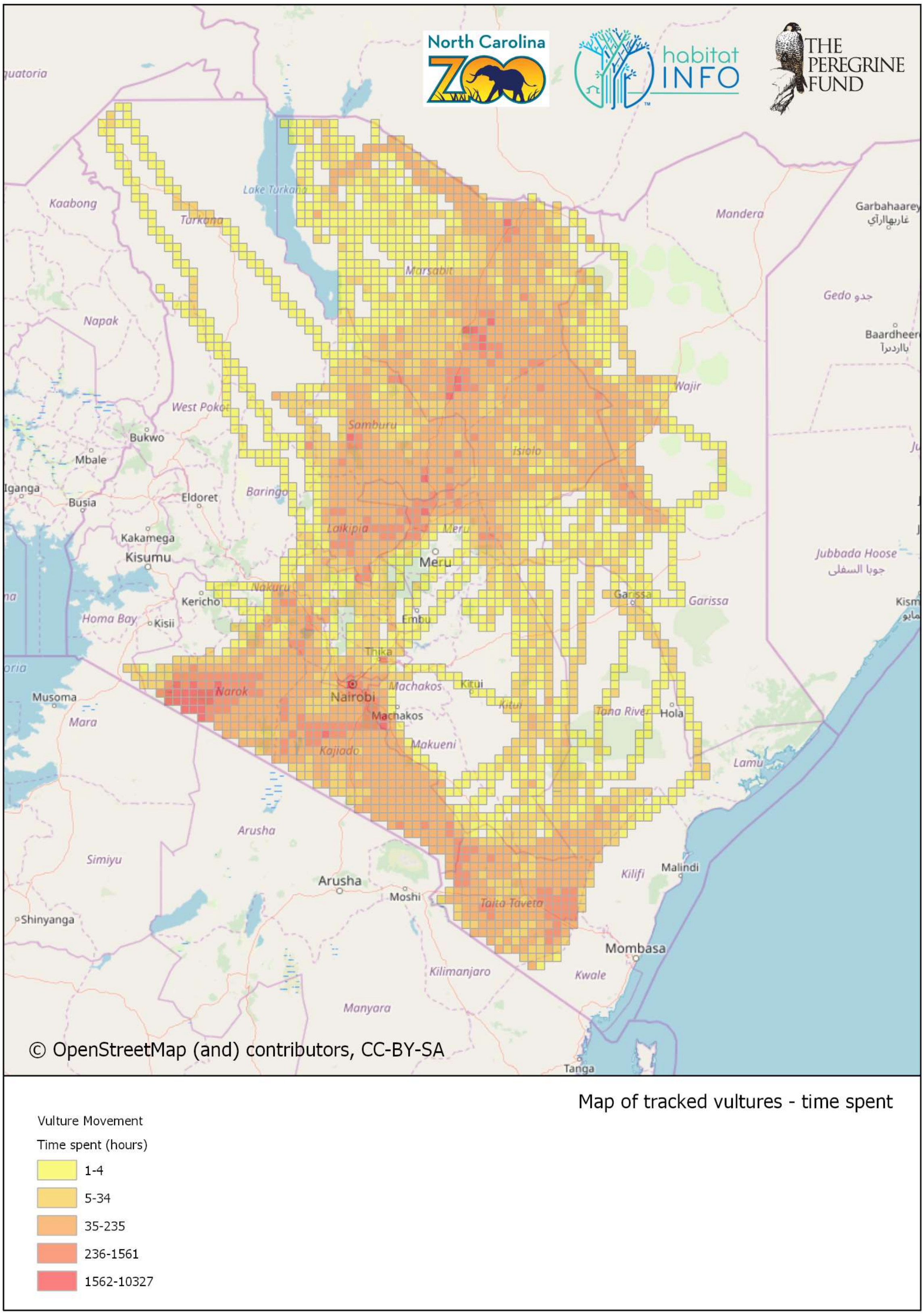

Figure 9-21. Time spent by tagged vultures mapped to Kenya Bird Map pentads

Use of an area by vultures is one of the most important elements of risk. It was important, therefore, that time spent by vultures in pentads was scored in a way to ensure that intense vulture use would not be 'diluted' by other variables, but would always trigger the highest level of risk. Vulture scores were therefore scaled to ensure that 'very high' vulture scores always resulted in a 'very high' overall rank when combined with other variables.

On the other hand, single vulture flights over an area should not be enough to trigger high sensitivity categories. Therefore, vulture activity was scored to ensure that low levels of activity (e.g. single tracks visible on the map of distance/time spent per pentad) did not result in an inappropriately high-risk level when combined with other variables.

The final heatmap of vulture activity by pentad is shown in Figure 9-22. This shows concentration of vulture activity in a broad band running south-west to north-east from the Masai Mara to Moyale, and in southern Kenya from the Masai Mara through to Tsavo. This corresponds closely with the distribution of vulture nest colonies (Figure 9-7), and the distribution of Kenya's major savannah protected areas and major wildlife conservancies, as well as pastoralist areas where livestock are concentrated.

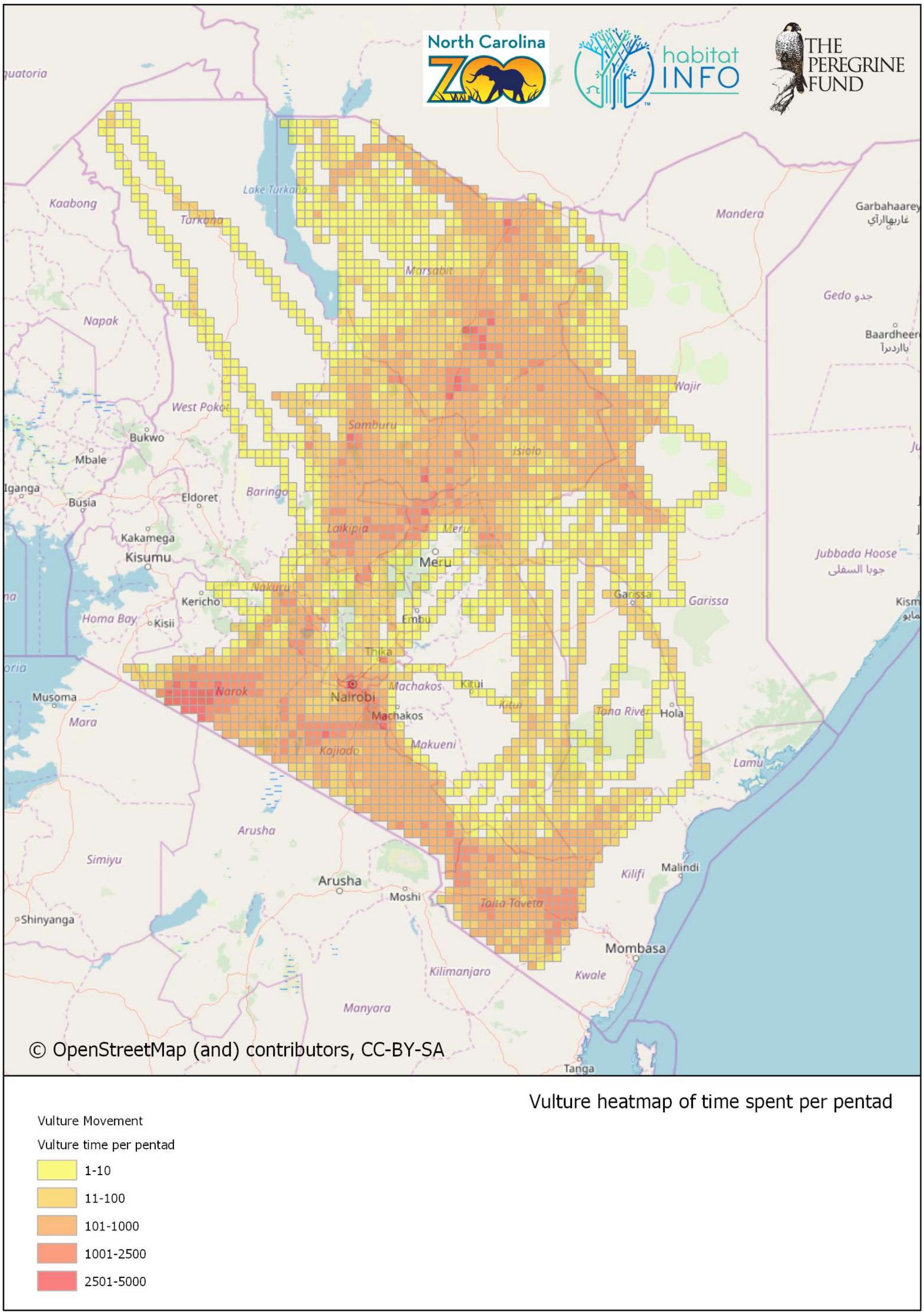

Figure 9-22. Vulture activity heatmap for time spent per pentad.

9.5.8.5 COMBINED HEATMAP FOR SPECIES VECS

Finally, the pentad scores for area of habitat weighted species richness, weighted species observations, and vulture movements were combined to give an overall species VEC heatmap of biodiversity risk for wind power (Figure 9-23).

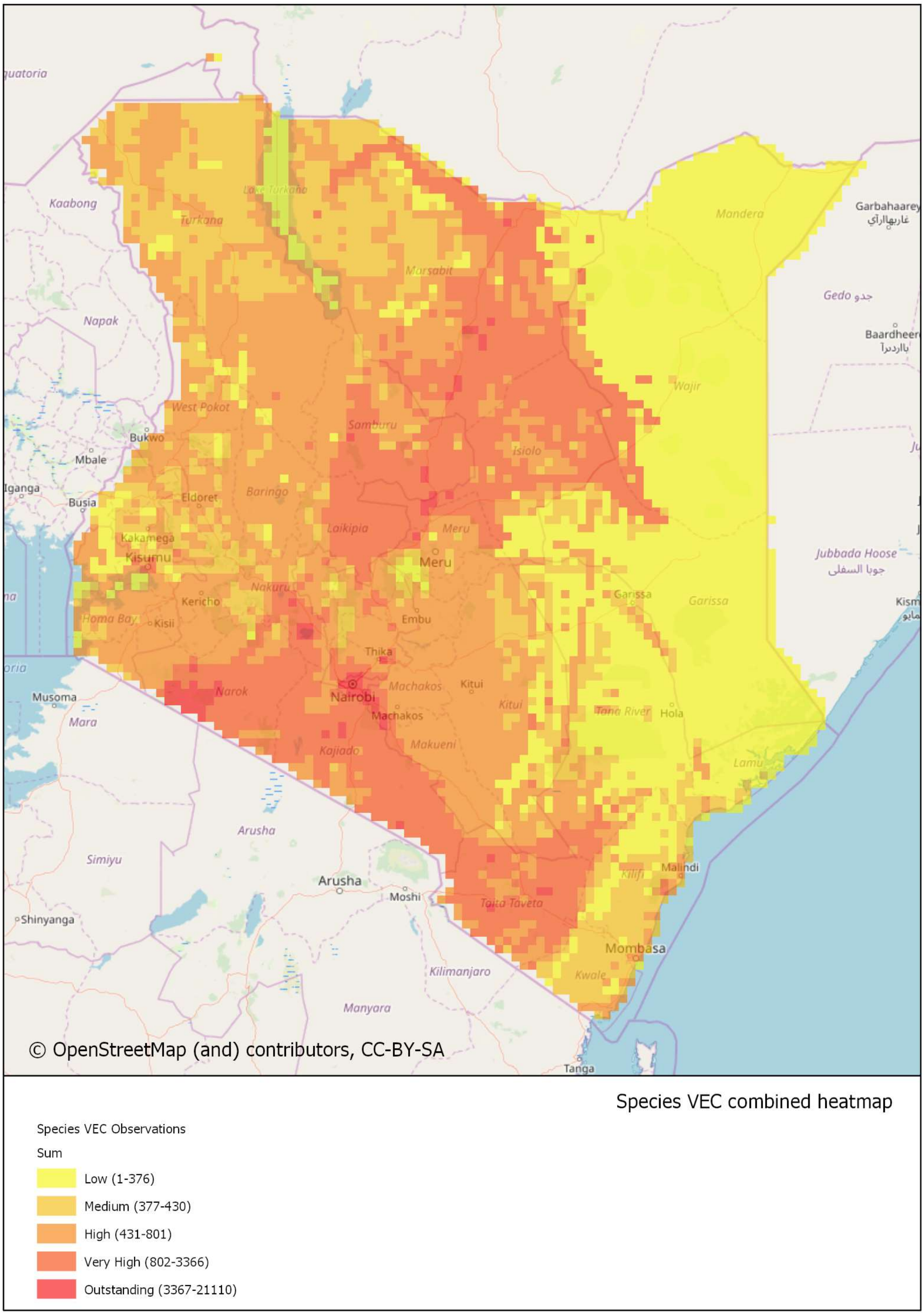

Figure 9-23. Combined species VEC heatmap, produced by adding scores for area of habitat weighted species richness, weighted observations, and vulture movements

9.5.8.6 VEC SITE HEATMAP

VEC site features were mapped to pentads, and weighted using the scores in Table 5. These scores reflect the different biodiversity risks posed by IBAs depending on the bird species that trigger their identification.

Figure 9-24 shows the pentad maps for VEC features.

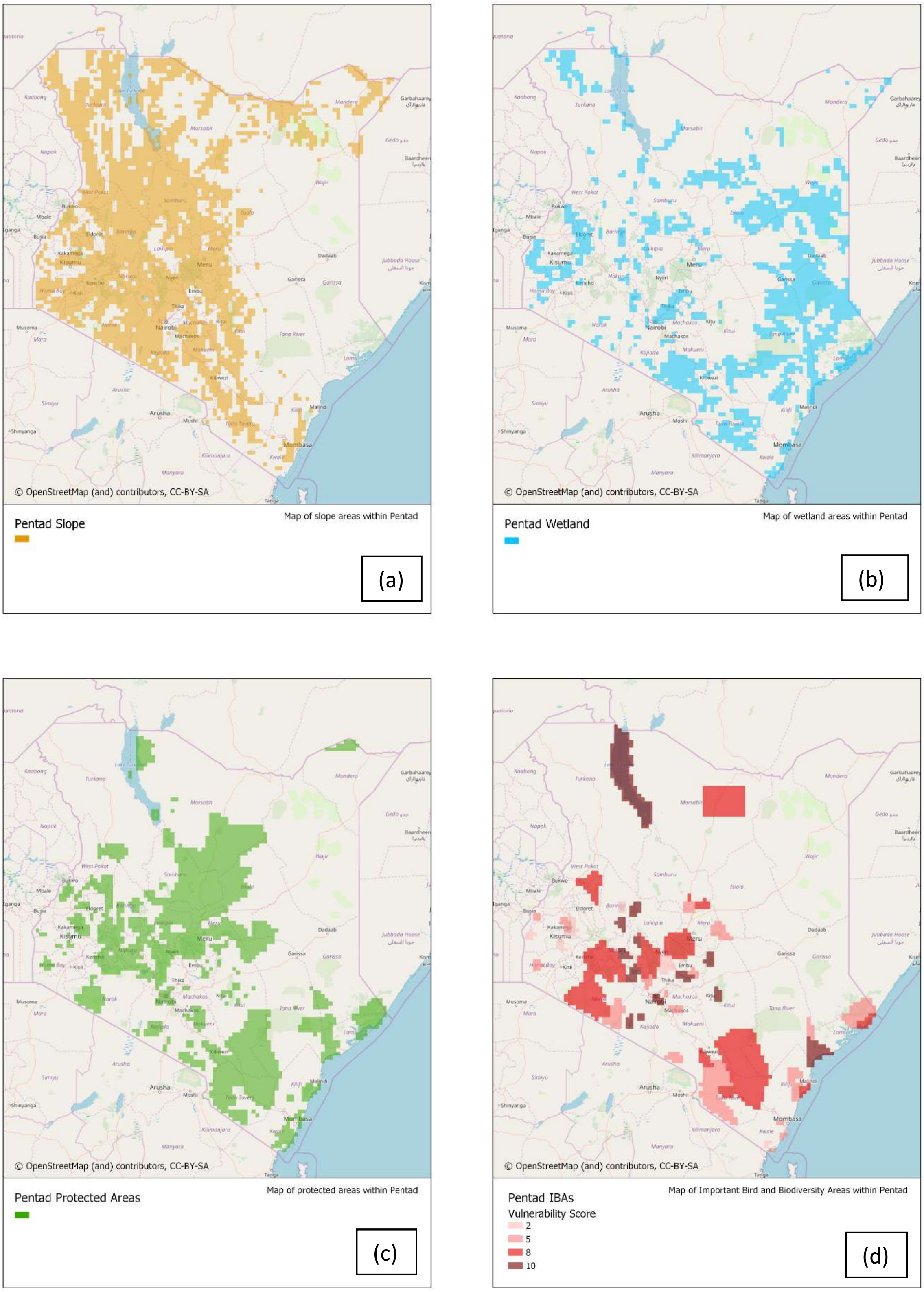

Figure 9-24. VEC site features mapped to Kenya Bird Map pentads, for (a) ridgelines, (b) wetlands, (c) Protected Areas, (d) Important Bird and Biodiversity Areas.

Table 8-5. Vulnerability weighting scores used for site VEC heatmapping

Vulnerability Category	Vulnerability category	Weighting
IBA with a Very High scoring VEC species or with Congregatory bird triggers	Very High	10
IBA with more than one Low, Moderate or High VEC Species trigger	High	8
IBAs with one Low, Moderate or High VEC Species trigger	Medium	5
Other IBA	Low	2
Ridgelines	Potential	1
Wetlands	Potential	1
Protected Areas	Potential	1

Figure 9-25 shows the combined and categorized VEC site heatmap scores for Kenya.

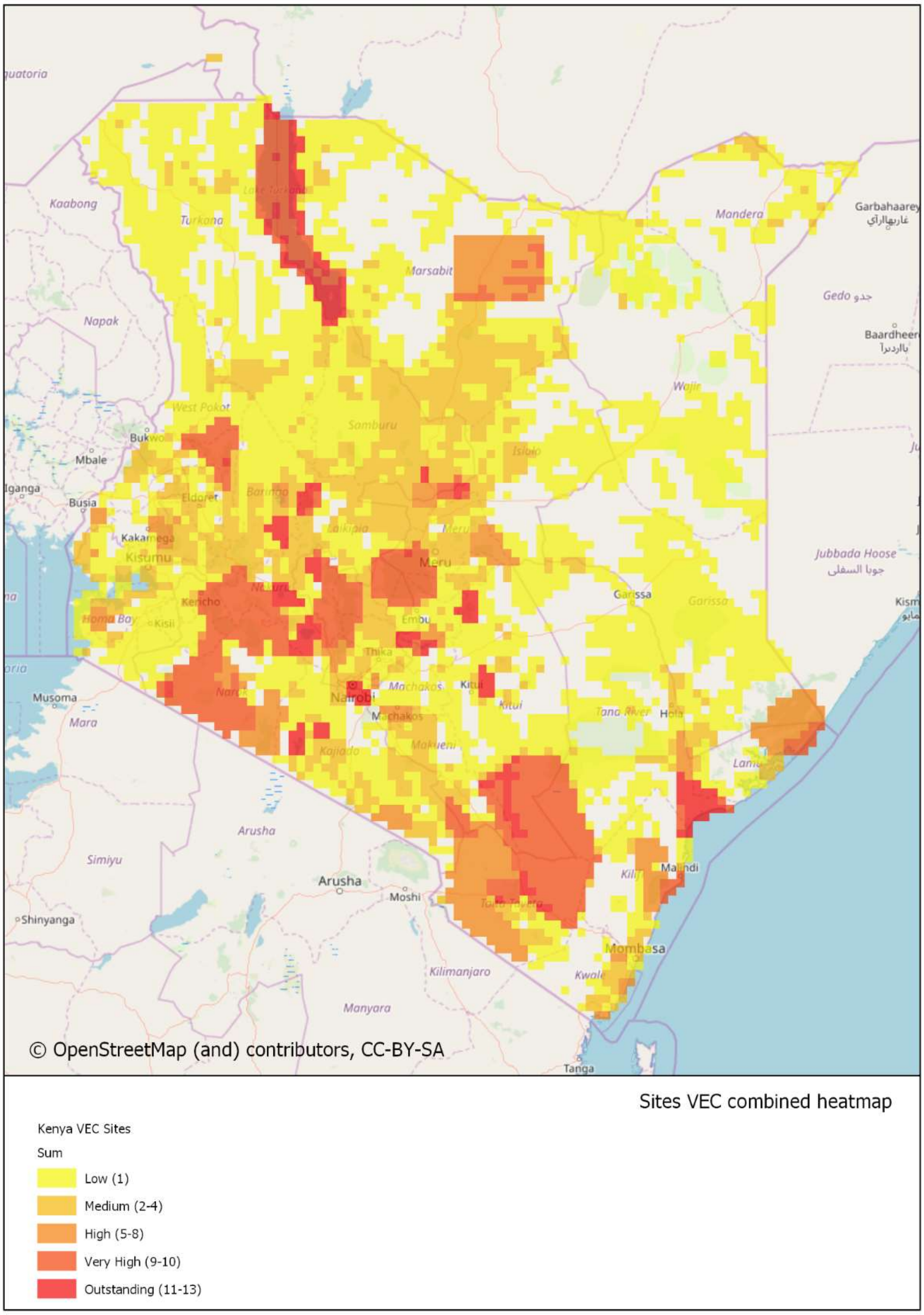

Figure 9-25. Combined VEC site heatmap, showing overall vulnerability score.

9.5.9 COMBINED SENSITIVITY MAPS

Finally, we overlaid the synthesis heatmaps of risk for species and site VECs with the locations of planned and potential wind energy developments, and with economic wind areas in Kenya (see Section 7), to identify locations at risk.

9.5.9.1 SPECIES SENSITIVITY

The overall 'heat map' for species sensitivity is shown in Figure 9-26Figure 9-30. Broadly speaking, areas of elevated sensitivity (Very High or Outstanding) are concentrated in a band running north-east to south-west across the central part of the country, from Moyale to the Masai Mara, and along the southernmost part of the country from Narok to Taita Taveta counties. Pentads with Outstanding sensitivity are concentrated in the Masai Mara area, east and south of Nairobi, in Tsavo and around Nakuru, Isiolo and Marsabit.

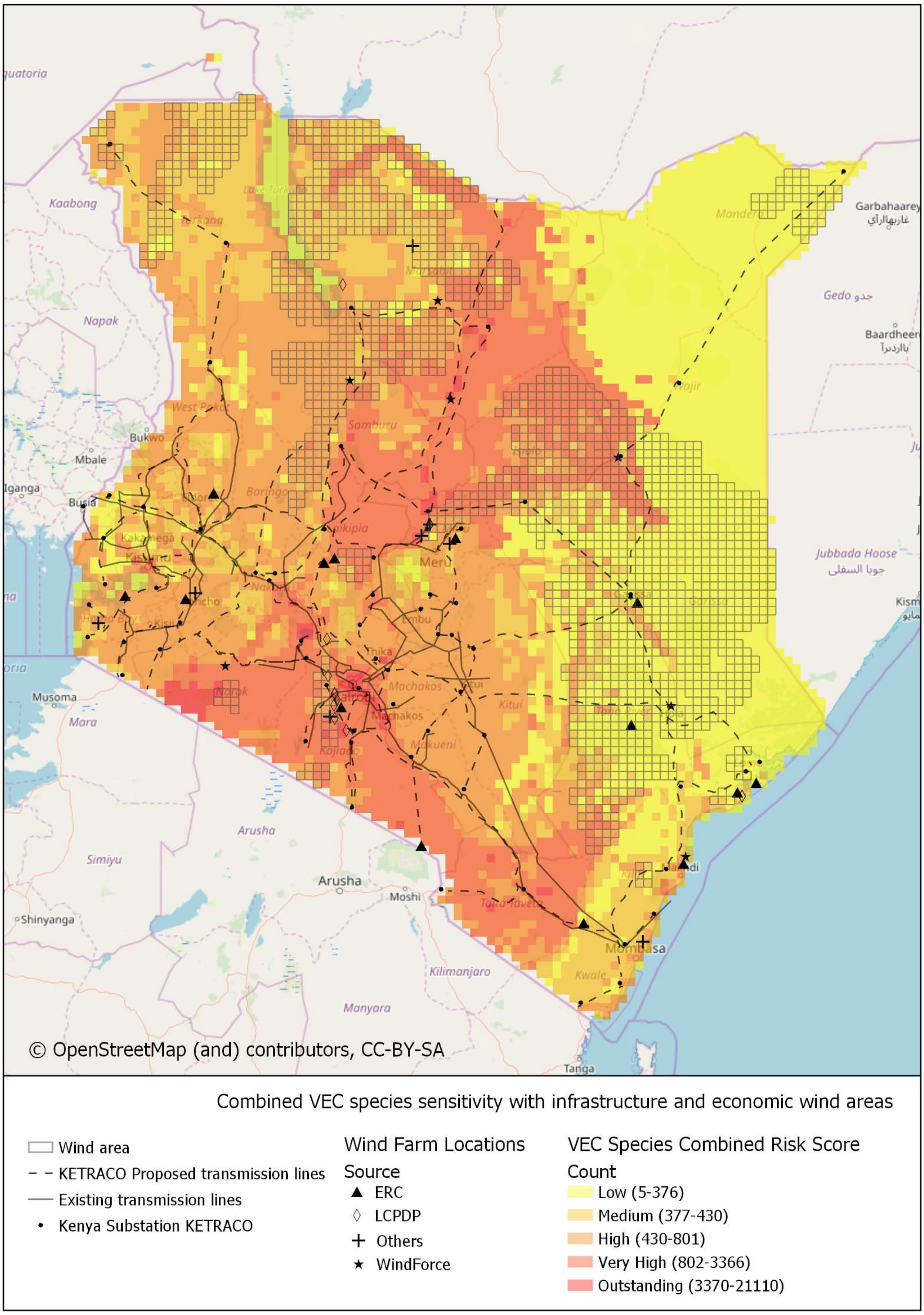

Figure 9-26. Synthesis VEC species heatmap overlaid with economic wind area and planned/potential developments

9.5.9.2 SITE SENSITIVITY

Pentads with Very High or Outstanding site sensitivity are scattered across Kenya (Figure 9-27), largely reflecting the location of Important Bird and Biodiversity Areas, particularly wetlands sites identified as important for specific VECs. Vulture colonies are distributed in a broad band running south-west to north-east from the Masai Mara to Moyale, as well as in Tsavo, closely congruent to the band of elevated sensitivity for species VECs (see section 9.5.9.1). Bat colonies are scattered but mainly concentrated at the Kenya coast, far western Kenya, and in the central Rift Valley and highlands.

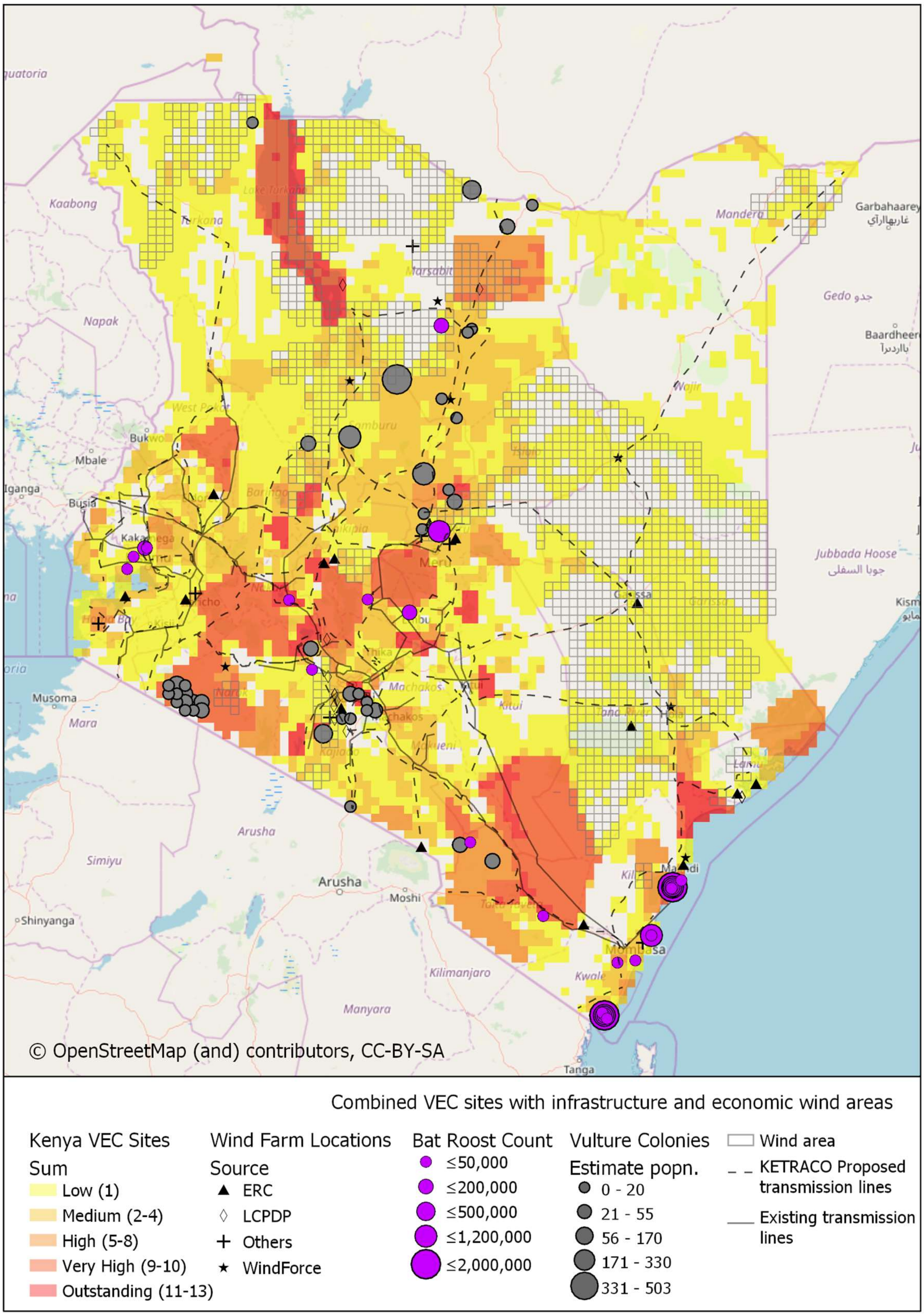

Figure 9-27. Synthesis VEC sites heatmap overlaid with economic wind area and planned/potential developments, as well as locations of major bat and vulture colonies

9.5.9.3 SENSITIVITY IN ECONOMIC WIND AREA

Overall, most of the economic wind area is not a high risk for biodiversity, suggesting that avoidance of risk is a broadly feasible option, given advanced planning (Figure 9-29 and Figure 9-30).

Figure 9-28 summarizes this information. The pie charts of pentad area in each sensitivity category show that species sensitivity is, overall, much greater than site sensitivity in economic wind areas; and that a substantial proportion of pentads are 'very high' sensitivity for species. A small proportion of pentads (only 0.1%, 171 pentads) are 'outstanding risk' for species, though 2% are in the highest category (2,903 pentads) for sites.

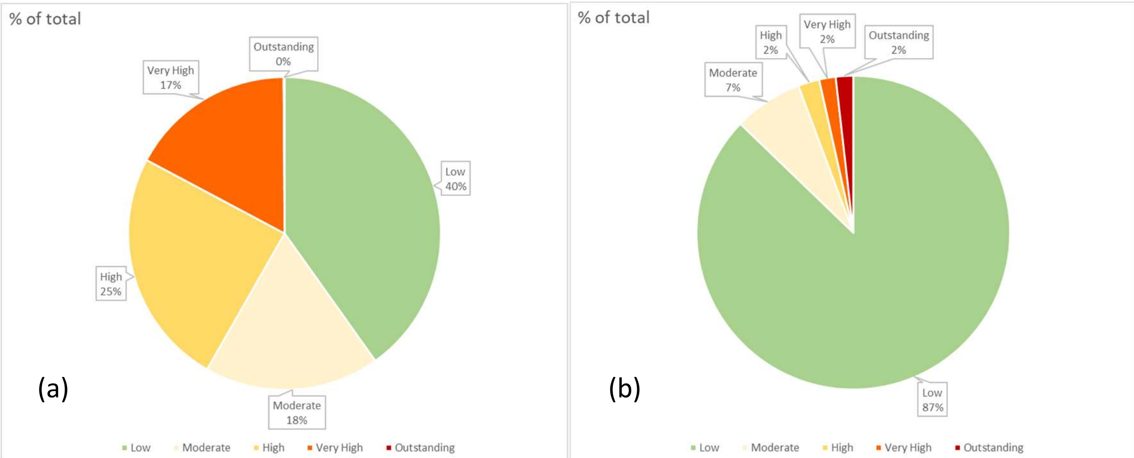

Figure 9-28. (a) Proportional distribution of combined VEC species sensitivity categories across the economic wind area in Kenya. Of 16,3233 km^2 of economic wind area in total, 27,935 km^2 is 'Very High' and 171 km^2 'Outstanding'. (b) Proportional distribution of combined VEC site sensitivity categories across pentads in the economic wind area in Kenya. Of 16,3233 km^2 in total, 2,733 km^2 is 'Very High' and 2,903 km^2 'Outstanding'.

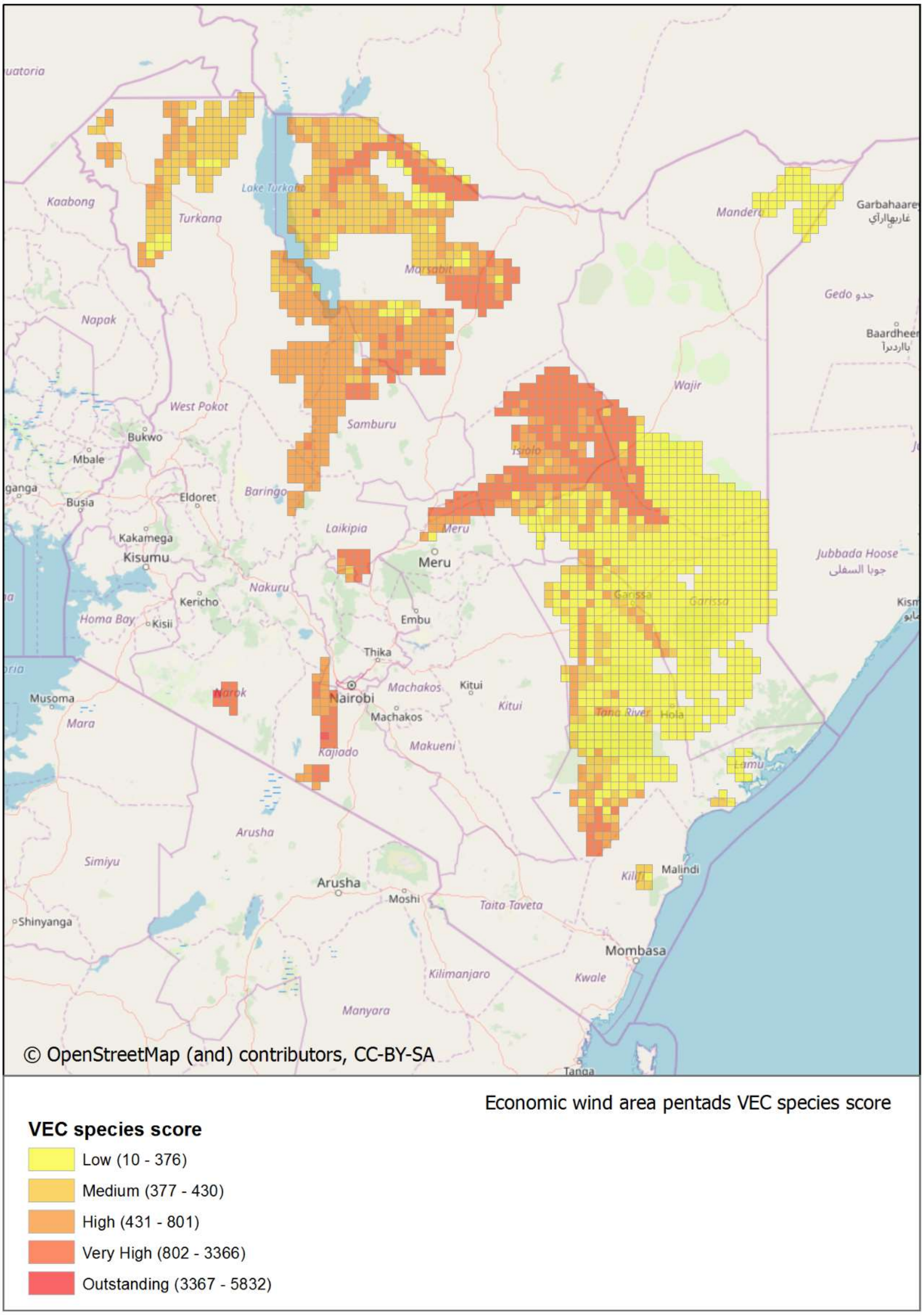

Figure 9-29. Sensitivity categories for pentads within economic wind areas in Kenya, based on the synthesis VEC species risk heatmap.

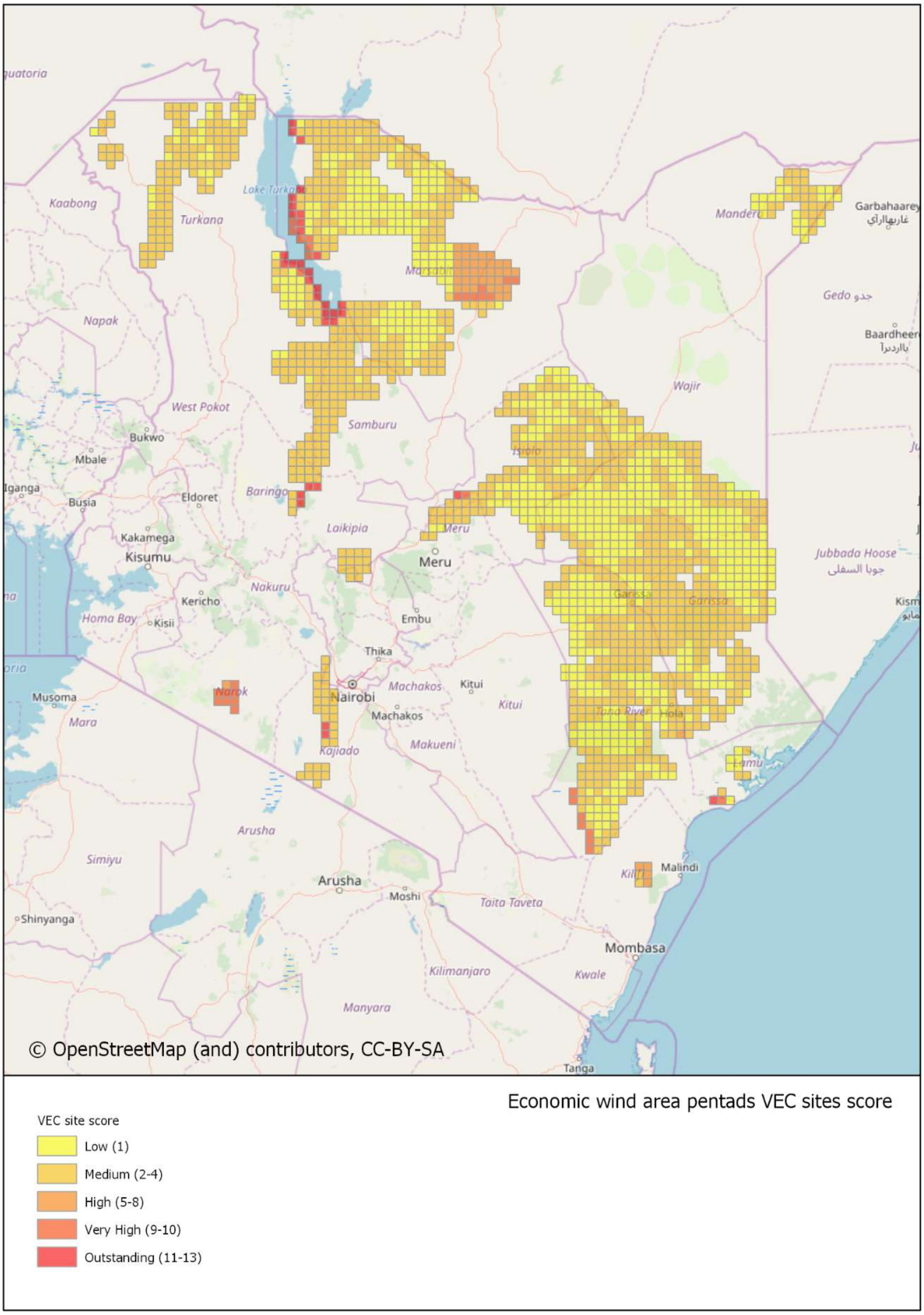

Figure 9-30. Sensitivity categories for pentads within economic wind areas in Kenya, based on the synthesis VEC sites risk heatmap.

9.5.10 COUNTY-LEVEL ASSESSMENT

Different counties vary not only in their wind resource but in the biodiversity sensitivity of areas that have wind potential. Figure 9-31 shows for each county the number of pentads with economic wind area (counties with none are not included), and the number of these pentads that are of very elevated risk – i.e. classed as Very High or Outstanding Sensitivity, for species, for sites, and for both. For most counties elevated species and site sensitivity overlap, but not completely.

Several things are evident from the chart:

- Generally, biodiversity risk is driven by species sensitivity rather than site sensitivity in these counties with areas of economic wind potential.
- Several counties have a high proportion of very elevated risk in their economic wind areas – these include Narok, Laikipia, Meru, Kajiiado and Isiolo. With the exception of Narok, however, some economic wind pentads in these counties do have more manageable levels of risk (in the Low, Moderate or High sensitivity categories). In Narok, the limited wind resource is all at very elevated risk.
- Several counties have many pentads with very elevated risk, but also many where risk levels are lower (in the Low, Moderate or High sensitivity categories). These include Wajir, Marsabit and Garissa.

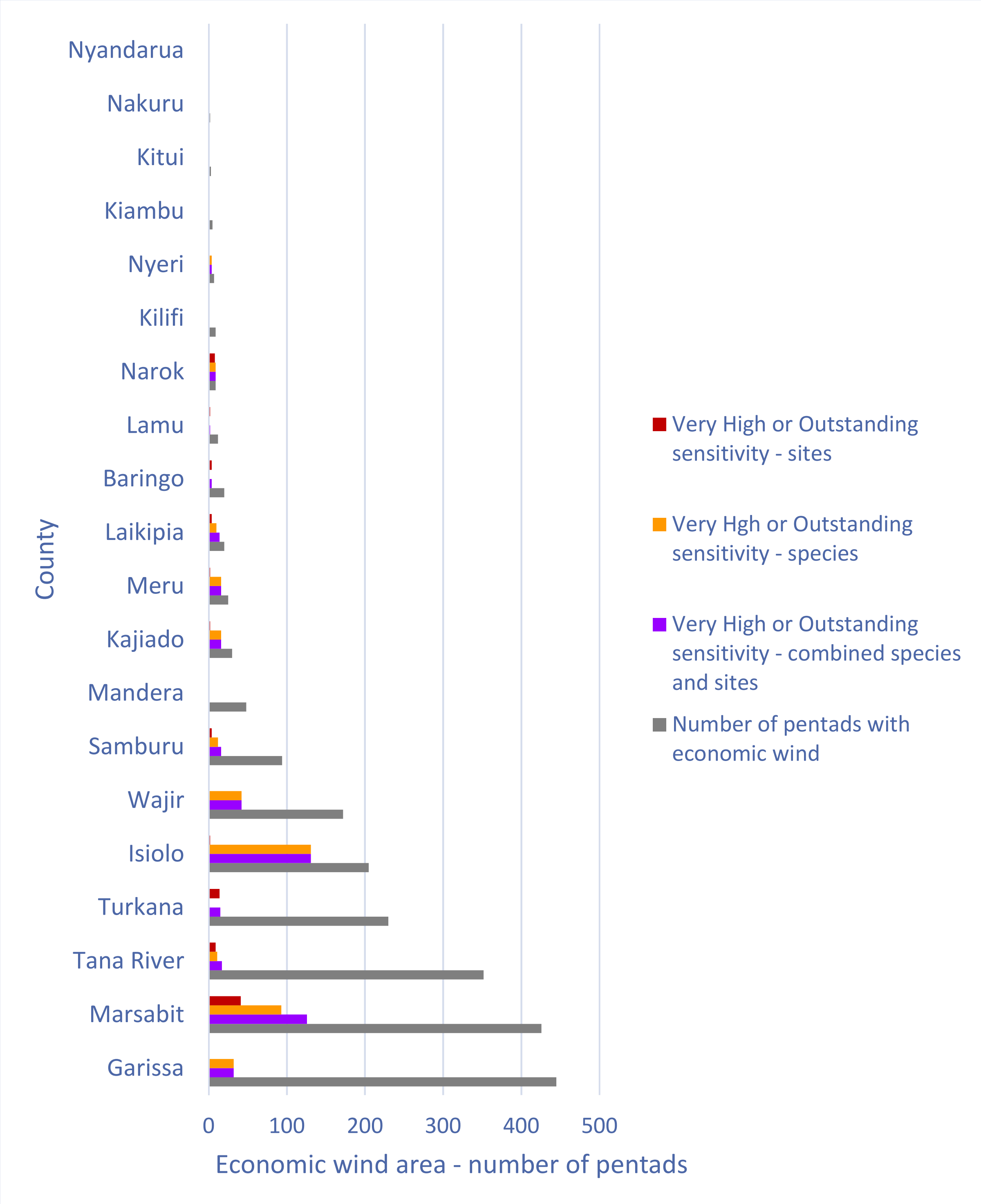

Figure 9-31. Number of pentads per county with economic wind potential that have very elevated (Very High or Outstanding) biodiversity sensitivity for species, for sites and for species and sites combined

9.5.11 RISK TO CURRENT, PLANNED AND POTENTIAL WIND DEVELOPMENTS

Another aspect of risk is the sensitivity of pentads with current, planned and potential wind developments. Figure 9-32 shows that the sensitivity of most pentads containing wind farm sites is Low, Moderate or High, i.e. not of very elevated risk, though High risks may still require careful management. No project is in a pentad that also contains a mapped bat or vulture colony.

However, there is very elevated risk for one development in each of Narok, Nakuru, Laikipia and Wajir, and for several developments in each of Marsabit and Kajiado. In Kajiado, there are seven projects with developments at very elevated risk, four of which have a vulture colony in at least one adjacent pentad. Meru has no developments in pentads at very elevated risk, but five developments have a vulture colony, and four of these a bat colony also, in at least one adjacent pentad (Figure 9-32 inset).

Figure 9-33 and Figure 9-34 highlight the sensitivity categories of pentads containing current, planned or potential wind energy developments, for species and site risk respectively.

Pentad sensitivity categories and related data for the developments listed in Table 7-4 are shown in A.2.

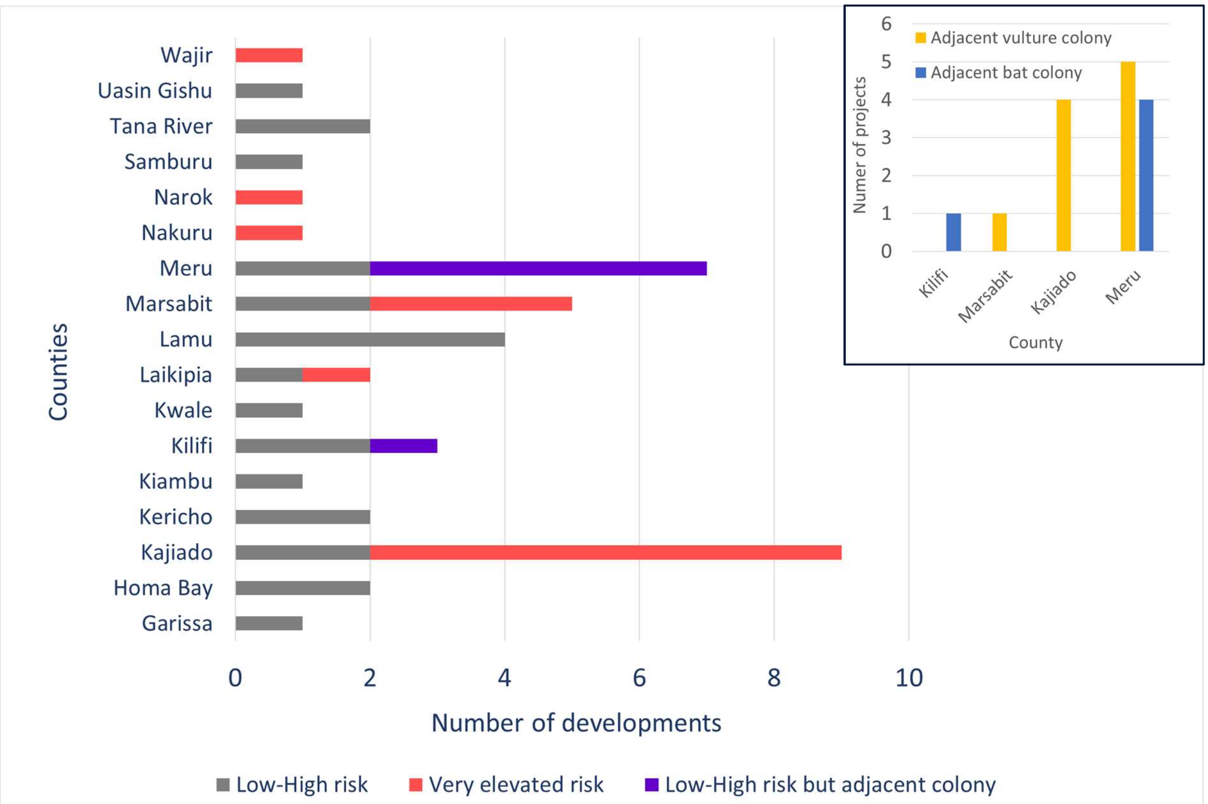

Figure 9-32. Summary of pentad sensitivity (sites and species combined) for current, planned and potential wind power developments in Kenya. 'Adjacent colonies' means that the pentad is not itself of very elevated risk (i.e. it is categorised as Low, Moderate or High risk, but not Very High or Outstanding), but it is adjacent to a pentad containing a mapped bat roost or vulture colony. Inset chart shows the number of pentads with wind developments adjacent to a pentad with a vulture or bat colony.

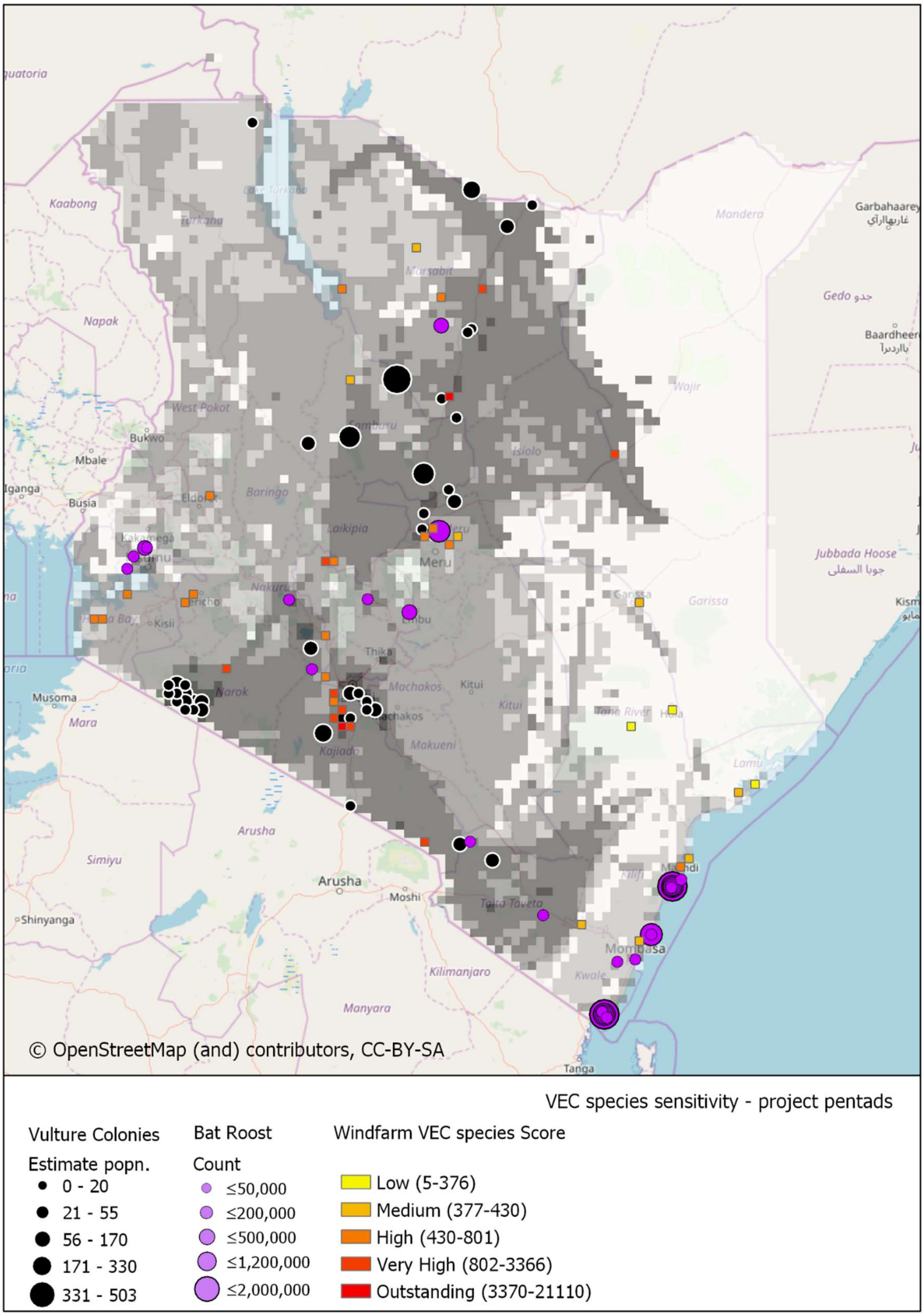

Figure 9-33. Species sensitivity categories for pentads (in colour) where there are planned or potential wind energy development in Kenya. Categories are based on the synthesis VEC species risk heatmap. Locations of major bat and vulture colonies are also shown.

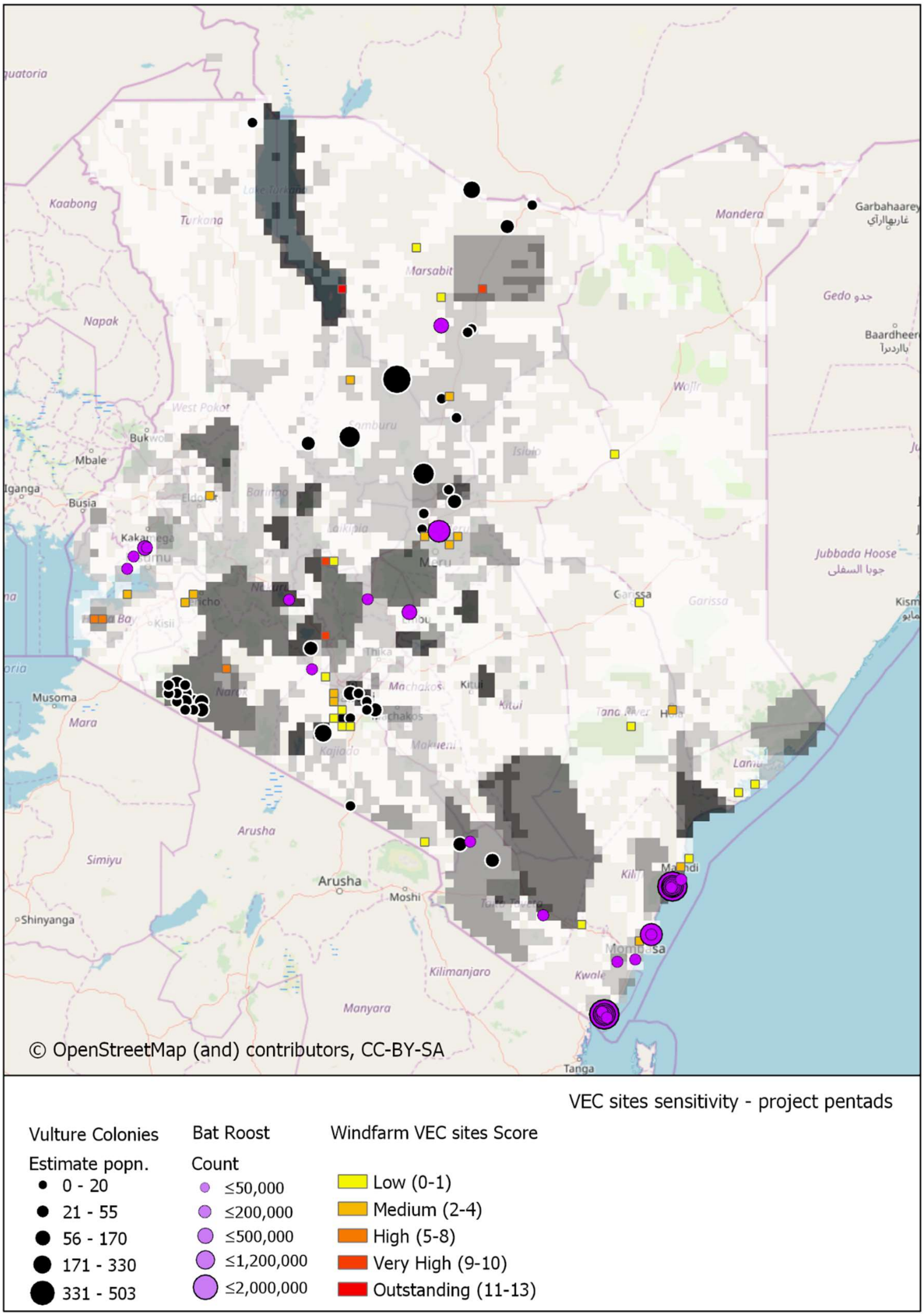

Figure 9-34. **Site sensitivity categories for pentads (in colour) where there are planned or potential wind energy development in Kenya. Categories are based on the synthesis VEC species risk heatmap. Locations of major bat and vulture colonies are also shown.**

Table 9-5 lists current, planned or potential wind energy developments in pentads of elevated sensitivity for either species or site VECs.

Three development are in pentads of Outstanding sensitivity: Kipeto in Kajiado, Laisamis in Marsabit (both for species VECs) and Lake Turkana in Marsabit (for site VECs). Lake Turkana is operational and Kipeto is in construction, so the option to avoid potential impacts is not available for these developments, and they must rely on minimising and, if necessary, offsetting impacts (see section 10.2).

Two planned developments, Marsabit Phase 1 (Marsabit) and Ndaragua (Laikipia) are in pentads of Very High sensitivity for both species and site VECs.

Actions to take if screening indicates elevated sensitivity are described in section 10.2 and summarised in Box 10-2.

Table 9-5. Current, planned or potential wind farms located in pentads with elevated sensitivity for species or site VECs

Development	County	Sensitivity	Type
Aeolus Kinangop	Nakuru	Very High	Site
Chania Green	Kajiado	Very High	Species
Esidai-Frontier Market Energy	Kajiado	Very High	Species
Habasweni	Wajir	Very High	Species
Kipeto - Phase I&II	Kajiado	Outstanding	Species
Laisamis	Marsabit	Outstanding	Species
Lake Turkana - Phase I	Marsabit	Outstanding	Site
Marsabit Phase I - KenGen	Marsabit	Very High	Species
Marsabit Phase I - KenGen	Marsabit	Very High	Site
Narok	Narok	Very High	Species
Ndaragua	Laikipia	Very High	Species
Ndaragua	Laikipia	Very High	Site
Ngong 1 - Phase III	Kajiado	Very High	Species
Ngong 1 - PhaseI&II	Kajiado	Very High	Species
Olchoro Onyore	Kajiado	Very High	Species
Oloitokitok	Kajiado	Very High	Species

9.6 CUMULATIVE IMPACT ASSESSMENT

With a large number of current, planned and potential on-grid wind farms in Kenya, some of them in very sensitive locations, the issue of cumulative impacts requires attention. Cumulative impacts are an important concern for any sector, but particularly for wind, because impacts need to be considered at a broad scale. Many species at risk of collision move over large distances, in the course of which individuals could encounter many wind farms, putting them at risk multiple times. The more wind farms and transmission lines in its foraging range or migration route, the higher the risk of collision for an individual bird or bat.

A meaningful assessment of cumulative impact for VEC bird and bat species is very difficult with the data presently available, and within the constraints of the SEA timetable. Information on species movements, passage rates over wind farm locations, and collision risk at those sites is either lacking or not accessible. At this point, it is possible only to examine in a general way which species may be most at risk at population level from potential cumulative impacts.

This is a first step in addressing the question as to whether cumulative bird and bat deaths from wind turbines are significant at population level, and/or in relation to all other anthropogenically-caused bird deaths for priority VECs. That is difficult to answer definitively, since there is poor documentation for most species of either natural mortality rates or fatalities resulting from many types of human activities. The demographic ramifications of that mortality is also poorly understood for most bird species. Information for most bird species in Africa is very limited, and for bat species is even more sparse.

One way to achieve some insight is through a first-cut analysis of Potential Biological Removal (PBR). This is a measure of the number of individuals that can be removed from a population annually by human-induced mortality (e.g. through hunting, or collisions with infrastructure) without causing noticeable population-level effects. PBR can be viewed as a measure of the 'spare' capacity created by a population's intrinsic ability to increase.

In reality, many of the bird VECs in this study have populations that are declining, not stable or increasing – suggesting there is no such 'spare' capacity at present. PBR is still a useful measure to calculate, as it provides an indication of the likely proportional effect on a species' population from cumulative impacts. For example, cumulative impacts will have a relatively lower population-level effect on a declining species with a large PBR compared to one with a small PBR.

Calculation of PBR depends on:

- Annual recruitment rate, i.e. the number of new individuals joining the population, which can be estimated from annual survival rate and the age of first breeding
- Population size
- Conservation status, which may affect the species' ability to attain the theoretical annual recruitment rate.

In terms of cumulative impact assessment, PBR is one way to define a limit of acceptable change for VECs.

We estimated PBR (for birds only, not bats) using the formula

$$\mathbf{PBR = \frac{1}{2}\, R_{max} \bullet N_{min} \bullet f}$$

Where $\mathbf{R_{max}}$ is the maximum annual recruitment rate, $\mathbf{N_{min}}$ is a conservative estimate of population size and **f** is a 'recovery factor' that can range between 0.1 and 1, and reflects the ability of the population to attain the maximum annual recruitment rate – so, for purposes of estimation, is scaled according to extinction threat category (S. Hulka, in litt., Dillingham & Fletcher 2008 and references therein).

R_{max} is calculated using estimates of survival rate **s** and age at first breeding **a** using the formula:

$$\mathbf{R_{max} = \{[(sa - s + a + 1) + ((s - sa - a - 1)^2 - 4sa^2)^{0.5}]/2a\} - 1}$$

Dillingham & Fletcher (2008) adapted the method of Wade (1998) to provide a correction factor to calculate **N_{min}** from a population size estimate. This involves a multiplier of approximately 0.92.

Dillingham & Fletcher (2008) recommend using **f** values of 0.1 for threatened species, 0.3 for near-threatened species, 0.5 for least-concern species with declining or unknown population trends, and 1.0 for least concern species known to have increasing or stable populations.

Using these parameters, PBR was calculated for bird species VECs based on data supplied by BirdLife International for annual survival, age at first breeding, population size range, global threat status and population trend. To be precautionary, we used the lowest estimate of population size. Where no estimate of population size was available, a precautionary estimate was made to the order or magnitude (e.g. 1,000, 10,000 or 100,000) based on expert judgement.

Calculated PBR values are shown in Table 9-6. Figure 9-35 shows the number of species (and whether their populations are stable/increasing or declining) in four categories of PBR constraint: outstanding (100 or fewer), very high (>100 but <1000), high (>1000 but <10,000), moderate (>10,000 but <100,000) and low (>100,000).

The Red List data refer to global population trends. Species population trends in Kenya could be different – a species that is declining globally could be stable or increasing in Kenya, or vice versa. The relatively high rate of habitat loss and degradation in Kenya compared to many countries suggests that many Kenyan VEC species are likely to be in significant decline, whatever the global trends.

Table 9-6. First-cut estimates of Potential Biological Removal for VEC bird species included in this assessment. Information on population decrease and threat category from BirdLife International.

English name	Scientific name	Sensitivity category	Decreasing?	PBR	Threat category
Saddle-bill Stork	*Ephippiorhynchus senegalensis*	High	Y	43	Least Concern
Martial Eagle	*Polemaetus bellicosus*	Very high	Y	49	Vulnerable
S. Banded Snake-Eagle	*Circaetus fasciolatus*	Moderate	Y	50	Near Threatened
Ayres's Hawk-Eagle	*Hieraaetus ayresii*	High	N	62	Least Concern
Bearded Vulture	*Gypaetus barbatus*	High	Y	63	Near Threatened
Mountain Buzzard	*Buteo oreophilus*	Moderate	Y	68	Near Threatened
Bat Hawk	*Macheiramphus alcinus*	High	N	74	Least Concern
Taita Falcon	*Falco fasciinucha*	High	Y	90	Vulnerable
Fox Kestrel	*Falco alopex*	High	N	110	Least Concern
Imperial Eagle	*Aquila heliaca*	Very high	Y	140	Vulnerable
White-headed Vulture	*Trigonoceps occipitalis*	Very high	Y	150	Critically Endangered
Greater Spotted Eagle	*Clanga clanga*	Very high	Y	220	Vulnerable
Lappet-faced Vulture	*Torgos tracheliotos*	Very high	Y	230	Endangered

Crowned Eagle	*Stephanoaetus coronatus*	Moderate	Y	250	Near Threatened
Blue Swallow	*Hirundo atrocaerulea*	High	Y	260	Vulnerable
Secretarybird	*Sagittarius serpentarius*	High	Y	410	Vulnerable
Sooty Falcon	*Falco concolor*	High	Y	490	Vulnerable
Denham's Bustard	*Neotis denhami*	High	Y	600	Near Threatened
Heuglin's Bustard	*Neotis heuglinii*	Moderate	N	610	Least Concern
Kori Bustard	*Ardeotis kori*	High	Y	630	Near Threatened
Black-breasted Snake-Eagle	*Circaetus pectoralis*	High	N	690	Least Concern
Western Banded Snake-Eagle	*Circaetus cinerascens*	Moderate	Y	720	Least Concern
Black-bellied Bustard	*Lissotis melanogaster*	Moderate	Y	770	Least Concern
Rüppell's Vulture	*Gyps rueppelli*	Very high	Y	800	Critically Endangered
Maccoa Duck	*Oxyura maccoa*	High	Y	820	Vulnerable
African Swallow-tailed Kite	*Chelictinia riocourii*	Moderate	Y	940	Least Concern
Buff-crested Bustard	*Lophotis gindiana*	Moderate	N	950	Least Concern
Hartlaub's Bustard	*Lissotis hartlaubii*	Moderate	N	960	Least Concern
White-bellied Bustard	*Eupodotis senegalensis*	Moderate	Y	960	Least Concern
Verreaux's Eagle	*Aquila verreauxii*	High	N	970	Least Concern
Egyptian Vulture	*Neophron percnopterus*	Very high	Y	1,000	Endangered
Grey Crowned Crane	*Balearica regulorum*	Very high	Y	1,000	Endangered
African Marsh-Harrier	*Circus ranivorus*	High	Y	1,000	Least Concern
African Skimmer	*Rynchops flavirostris*	High	Y	1,100	Near Threatened
Sharpe’s Longclaw	*Macronyx sharpei*	High	Y	1,100	Endangered
African Cuckoo-Hawk	*Aviceda cuculoides*	Moderate	N	1,200	Least Concern
Bateleur	*Terathopius ecaudatus*	High	Y	1,200	Near Threatened
Brown Snake-Eagle	*Circaetus cinereus*	High	Y	1,300	Least Concern
African Hobby	*Falco cuvierii*	High	Y	1,400	Least Concern
White-backed Duck	*Thalassornis leuconotus*	Moderate	Y	1,400	Least Concern
Long-crested Eagle	*Lophaetus occipitalis*	High	N	1,600	Least Concern
Black Crowned Crane	*Balearica pavonina*	Very high	Y	1,600	Vulnerable

Saker Falcon	*Falco cherrug*	High	Y	1,600	Endangered
Dickinson's Kestrel	*Falco dickinsoni*	Moderate	N	1,800	Least Concern
Pallid Harrier	*Circus macrourus*	High	Y	2,100	Near Threatened
Black Stork	*Ciconia nigra*	High	N	2,200	Least Concern
Grasshopper Buzzard	*Butastur rufipennis*	High	Y	2,400	Least Concern
Levant Sparrowhawk	*Accipiter brevipes*	High	N	2,600	Least Concern
Woolly-necked Stork	*Ciconia episcopus*	High	Y	2,700	Least Concern
Lesser Spotted Eagle	*Clanga pomarina*	High	N	3,000	Least Concern
Ovambo Sparrowhawk	*Accipiter ovampensis*	Moderate	N	3,100	Least Concern
Steppe Eagle	*Aquila nipalensis*	Very high	Y	3,100	Endangered
Pink-backed Pelican	*Pelecanus rufescens*	High	N	3,700	Least Concern
Eleonora's Falcon	*Falco eleonorae*	High	N	3,900	Least Concern
Red-necked Falcon	*Falco chicquera*	High	Y	3,900	Least Concern
Little Sparrowhawk	*Accipiter minullus*	Moderate	N	4,800	Least Concern
Crab Plover	*Dromas ardeola*	Moderate	N	5,300	Least Concern
Yellow-billed Stork	*Mycteria ibis*	Moderate	Y	5,800	Least Concern
Tawny Eagle	*Aquila rapax*	High	Y	6,000	Vulnerable
African Hawk-Eagle	*Aquila spilogaster*	High	Y	6,300	Least Concern
Wahlberg's Eagle	*Hieraaetus wahlbergi*	High	N	8,600	Least Concern
African Harrier-Hawk	*Polyboroides typus*	Moderate	N	8,800	Least Concern
Osprey	*Pandion haliaetus*	High	N	9,200	Least Concern
Great Sparrowhawk	*Accipiter melanoleucus*	Moderate	Y	9,300	Least Concern
White-backed Vulture	*Gyps africanus*	Very high	Y	11,000	Critically Endangered
Long-legged Buzzard	*Buteo rufinus*	High	N	11,000	Least Concern
Montagu's Harrier	*Circus pygargus*	High	Y	11,000	Least Concern
Marabou	*Leptoptilos crumeniferus*	Moderate	N	12,000	Least Concern
African Goshawk	*Accipiter tachiro*	Moderate	Y	12,000	Least Concern
Hooded Vulture	*Necrosyrtes monachus*	Very high	Y	13,000	Critically Endangered
Peregrine Falcon	*Falco peregrinus*	High	N	13,000	Least Concern
Gabar Goshawk	*Micronisus gabar*	Moderate	N	13,000	Least Concern

Lanner Falcon	*Falco biarmicus*	High	N	14,000	Least Concern
African Swift	*Apus barbatus*	Moderate	N	15,000	Least Concern
Rufous-chested Sparrowhawk	*Accipiter rufiventris*	Moderate	N	15,000	Least Concern
Palm-nut Vulture	*Gypohierax angolensis*	Moderate	N	15,000	Least Concern
Horus Swift	*Apus horus*	Moderate	N	16,000	Least Concern
African Fish-Eagle	*Haliaeetus vocifer*	High	N	16,000	Least Concern
Great White Pelican	*Pelecanus onocrotalus*	High	N	16,000	Least Concern
Booted Eagle	*Hieraaetus pennatus*	High	N	18,000	Least Concern
Greater Kestrel	*Falco rupicoloides*	High	N	18,000	Least Concern
Roseate Tern	*Sterna dougallii*	Moderate	N	18,000	Least Concern
Gray Kestrel	*Falco ardosiaceus*	Moderate	N	20,000	Least Concern
Greater Flamingo	*Phoenicopterus roseus*	High	N	24,000	Least Concern
European Honey-buzzard	*Pernis apivorus*	High	Y	25,000	Least Concern
Abdim's Stork	*Ciconia abdimii*	High	Y	26,000	Least Concern
Pygmy Falcon	*Polihierax semitorquatus*	Moderate	N	26,000	Least Concern
Lesser Kestrel	*Falco naumanni*	High	N	29,000	Least Concern
African Openbill	*Anastomus lamelligerus*	High	N	31,000	Least Concern
Williams's Lark	*Mirafra williamsi*	Moderate	N	45,000	Least Concern
Lizard Buzzard	*Kaupifalco monogrammicus*	Moderate	N	48,000	Least Concern
European White Stork	*Ciconia ciconia*	High	N	49,000	Least Concern
Eurasian Marsh-Harrier	*Circus aeruginosus*	High	N	58,000	Least Concern
Eurasian Hobby	*Falco subbuteo*	High	Y	68,000	Least Concern
Augur Buzzard	*Buteo augur*	High	N	76,000	Least Concern
Red-footed Falcon	*Falco vespertinus*	High	Y	81,000	Near Threatened
Dark Chanting-Goshawk	*Melierax metabates*	Moderate	N	90,000	Least Concern
Eastern Chanting-Goshawk	*Melierax poliopterus*	Moderate	N	92,000	Least Concern
Black Kite	*Milvus migrans*	Moderate	N	99,000	Least Concern
Shikra	*Accipiter badius*	Moderate	N	120,000	Least Concern
Black-shouldered Kite	*Elanus caeruleus*	Moderate	N	140,000	Least Concern

Lesser Flamingo	*Phoeniconaias minor*	High	Y	150,000	Near Threatened
Nyanza Swift	*Apus niansae*	Moderate	N	150,000	Least Concern
Curlew Sandpiper	*Calidris ferruginea*	Moderate	Y	150,000	Near Threatened
Common Buzzard	*Buteo buteo*	High	N	150,000	Least Concern
Amur Falcon	*Falco amurensis*	High	N	220,000	Least Concern
Eurasian Sparrowhawk	*Accipiter nisus*	High	N	360,000	Least Concern
Tufted Duck	*Aythya fuligula*	Moderate	N	640,000	Least Concern
Eurasian Wigeon	*Mareca penelope*	Moderate	Y	750,000	Least Concern
Garganey	*Spatula querquedula*	Moderate	Y	800,000	Least Concern
Eurasian Kestrel	*Falco tinnunculus*	High	Y	1,000,000	Least Concern
Gadwall	*Mareca strepera*	Moderate	N	1,600,000	Least Concern
Northern Pintail	*Anas acuta*	Moderate	Y	1,800,000	Least Concern
Common Teal	*Anas crecca*	Moderate	N	2,000,000	Least Concern
Northern Shoveler	*Spatula clypeata*	Moderate	Y	2,900,000	Least Concern
Common Swift	*Apus apus*	Moderate	N	7,200,000	Least Concern

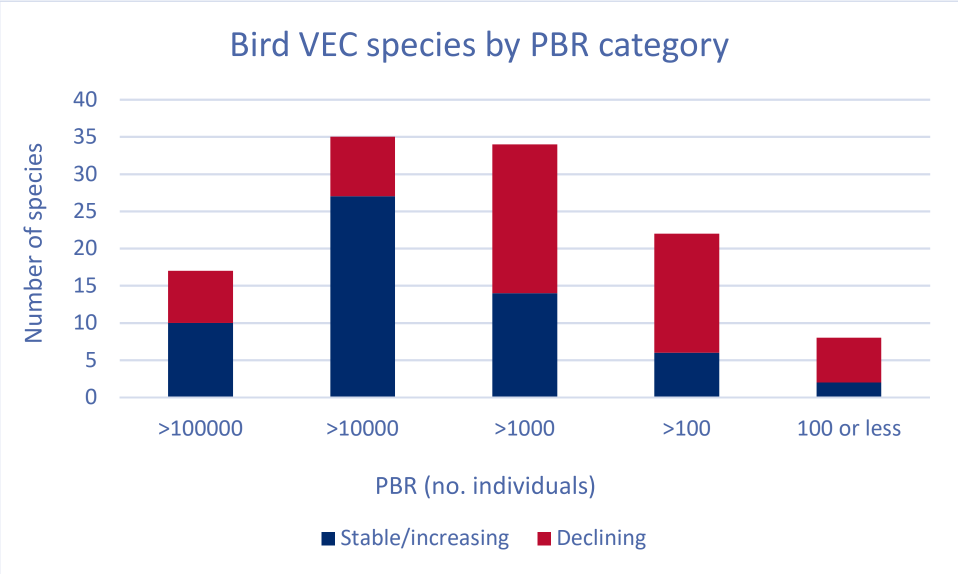

Figure 9-35. Proportion of VEC bird species included in this assessment in broad categories of PBR estimates. Information on population trend from BirdLife International.

The PBR numbers should not be taken too literally, as there are many uncertainties wrapped into these calculations. But they broadly represent limits of acceptable change for bird species VECs at *population level*. The limit of acceptable change thus covers cumulative impacts across a species' *whole range*, or across the whole flyway for a migratory species. For most of the species listed here, Kenya forms only a small part of the global range, probably 10% or less in most cases. For species with low PBRs therefore, the limit of acceptable change from cumulative impacts in Kenya is likely to be *very low*, only a handful of individuals at most – and for the most sensitive species, zero or near zero.

Not all species with low calculated PBRs are likely to collide with wind turbines. Some are assessed at only low or moderate vulnerability to collision. However, VEC species with 'outstanding' PBR constraints (PBRs of 100 individuals or fewer) include the very high-risk species Martial Eagle, and the high-risk species Saddle-bill Stork, Bat Hawk and Taita Falcon. VEC species with 'very high' PBR constraints (>100 to 1000 individuals) include the very high-risk Greater Spotted and Imperial Eagles, very high-risk Lappet-faced, Ruppell's and White-headed Vultures, and a number of high-risk bustard and raptor species, including Verreaux's Eagle, Black-breasted Snake-eagle, Secretarybird and Denham's and Heuglin's Bustards.

The implication of this analysis is that there are a number of species at risk of population-level effects from potential cumulative impacts of wind farms in Kenya. In these cases, wind power impacts would be adding to already severe existing pressures. This highlights the importance of effective mitigation to reduce impacts as near to zero as possible, and to compensate for impacts that remain (section 10.2).

9.7 ANALYSIS OF ALTERNATIVE PPP OPTIONS

A standard feature of SEAs is their focus on exploring alternative approaches to policies, plans, or programs. In the case of the Kenya wind power development sector, the content of the Energy Bill 2017 has provided direction in the Kenya energy development sector with a strong focus on promoting the development and use of renewable energy technologies. However, great flexibility remains in terms of the ways in which this is put into effect given the wide scope of potential renewable technologies, including but not limited to biomass, biodiesel, bioethanol, charcoal, fuelwood, solar, wind, tidal waves, hydropower, biogas and municipal waste.

Under the hierarchy of alternatives outlined in the National SEA Guidelines, this SEA will assume that the need and demand for power and production plans outlined in the policy and plan documents has considered appropriate alternatives at that level. Specifically, Kenya's energy needs cannot be met without expanding the renewable energy sector, and thus the wind power development plans cannot be reasonably avoided or substituted. Thus, this SEA focuses on the question of 'where' those developments should be situated. Sensitivity mapping has identified parts of the country where wind power development is viable and potential adverse impacts on biodiversity can be minimised. It has also identified a number of planned and potential projects situated in sensitive areas, and parts of the country with good wind potential but elevated risk of negative biodiversity impacts.

Wind developers take into consideration several factors when they decide where or whether to pursue development of a wind power project. These factors include the wind resource, accessibility and connection requirements, environmental risks and potential community impacts. In general, the places most suitable to place wind projects have strong and consistent winds; large, open spaces; reasonable access; minimal risk to wildlife; and supportive local communities.

Average wind speed, wind power density, and the capacity factor of a wind power plant are the typical metrics used to assess the wind characteristics at a geographical location, and to determine the feasible sites for establishment of wind farms (Cetinay et al. 2017). Further, those feasible geographical sites can be mapped onto other key elements like the electrical power grid, biodiversity distribution or ecologically sensitive areas, and social-culturally important sites in order to reach optimal siting and sizing of wind farms to maximise annual wind power generation while considering all other constraints (Cetinay et al. 2017).

This assessment provides the biodiversity element of that analysis, which can be used in a future step to inform a comprehensive evaluation and prioritisation of candidate areas for site selection of sustainable wind farms at a national level, adequate to support strategic spatial planning by policy-makers (e.g., Tsoutsos et al. 2015).

The current assessment already allows identification of four key scenarios based on information on wind and on biodiversity sensitivity (Figure 9-36).

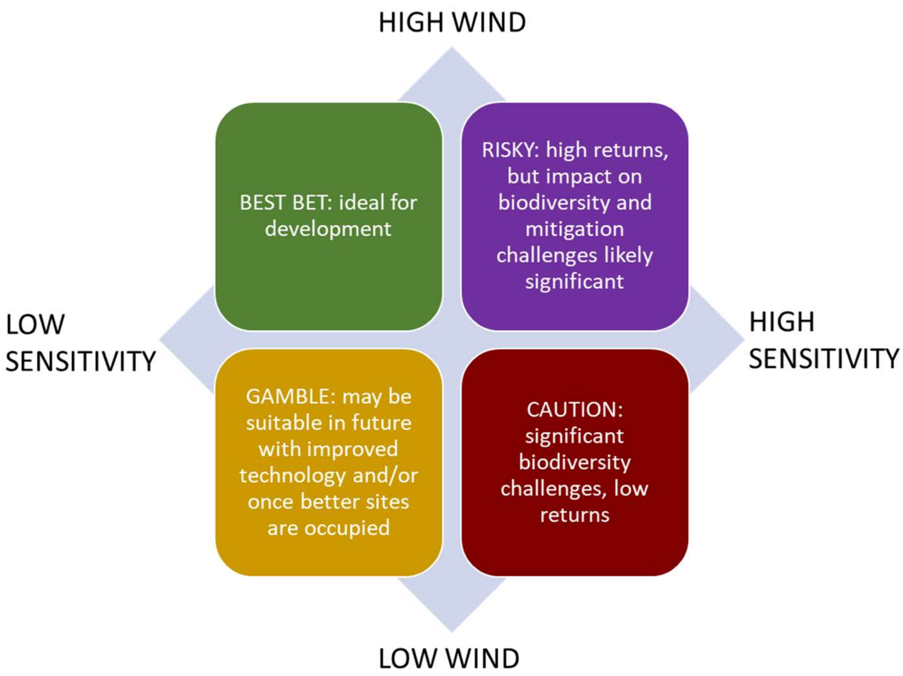

Figure 9-36: Four broad scenarios for wind power development decisions based on the wind resource level and the level of biodiversity sensitivity. The 'best bet' and 'risky' scenarios correspond broadly to the economic wind pentads categorised respectively as 'low' or 'moderate', and as 'high', 'very high' or 'outstanding', in Figure 9-29 and Figure 9-30

10 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

10.1 INTRODUCTION

The Environmental Management and Monitoring Plan (EMMP) outlines the actions required to effectively implement the mitigation measures and alternative options identified and recommended in the SEA. These actions are needed to reduce, manage and monitor adverse biodiversity impacts in the wind energy sector. An EMMP is a living plan to be used adaptively, and updated and amended as new information, technologies, policies and legal frameworks (including international agreements) become available.

This chapter provides guidance on mitigation measures stemming from the sensitivity assessment findings in chapter 9. It focuses on implementation of the mitigation hierarchy, a practical and widely-applied framework to help limit the negative environmental impacts of development projects. The mitigation hierarchy is the sequence of actions to anticipate and *avoid* impacts on biodiversity; and where avoidance is not possible, *minimize*; and where impacts occur, rehabilitate or *restore*; and where significant residual impacts remain, *offset* (CSBI 2015).

As this is a national, plan-level SEA, the focus is on the design and planning stages of wind power projects in Kenya. This represents the *avoidance* stage of the mitigation hierarchy, where careful siting can avoid negative impacts on biodiversity as far as possible. However, outline guidance is also provided on mitigation measures that should be considered during the construction, operational and de-commissioning stages of wind power projects, addressing the other three components of the mitigation hierarchy. This chapter does not attempt to duplicate the detailed guidance available elsewhere on assessing, mitigating and monitoring wind power impacts. Key guidance documents are listed, with weblinks, in A.3, and project proponents and consultants are advised to consult these for further information.

For specific projects, more detailed EMMPs will be required prior to start of construction, under the ESIA framework. During operations (post-construction), the focus of EMMPs will then shift towards on-going monitoring to ensure that the measures and mitigations established during construction continue to be effective. Operations EMMPs therefore draw on the measures and mitigations established in the construction EMMPs, but also establish protocols for regular monitoring and proactive and adaptive on-going management of project impacts.

10.2 MITIGATION OF IMPACTS

10.2.1 MITIGATION HIERARCHY

Kenya’s regulatory framework and good international industry practice both require that developers follow the mitigation hierarchy. This involves first avoiding project impacts, then minimising those that cannot be avoided, then restoring impacts so far as possible, before finally - as a last resort - offsetting any residual negative impacts (Box 10-1; CSBI 2015).

Avoidance and minimisation are particularly key stages in the mitigation hierarchy, as these serve to prevent impacts before they happen, rather than attempting to remediate them afterwards. For wind power projects, there is usually little scope for restoration of impacts, while offsets can be challenging, uncertain and costly. An emphasis on prevention is thus crucial.

Box 10-1 provides an overview of the Mitigation Hierarchy in more detail.

10.2.2 OVERVIEW

Box 10-1: The Mitigation Hierarchy

The mitigation hierarchy is a tool to help limit, as far as possible, the potential adverse impacts of development projects on biodiversity. It is crucial for all development projects that aim to achieve No Net Loss (no overall negative impact) or Net Gain (an overall improvement) for target biodiversity features. It is based on a series of sequential steps that should be implemented throughout the project's life cycle, namely:

1. **Avoidance**: the first step of the mitigation hierarchy comprises measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of infrastructure or disturbance. For example, placement of roads outside of rare habitats or key species' breeding grounds. Avoidance is often the easiest, cheapest and most effective way of reducing potential negative impacts, but it requires biodiversity to be considered in the early stages of a project. Depending on the context, avoidance may be through site selection (e.g. choosing a location with low biodiversity sensitivity), project design (e.g. choosing to install underground power cables to avoid bird collisions), or scheduling of project activities (e.g. timetabling project construction to avoid overlap with the nesting season of sensitive bird species).
2. **Minimisation**: measures taken to reduce the duration, intensity and/or extent of impacts that cannot be completely avoided. Minimisation may be through physical controls (e.g. installing bird diverters on a powerline); operational controls (e.g. curtailing turbines at low wind speeds to reduce bat collisions); or abatement controls (e.g. taking steps to prevent pollution from project activities).
3. **Rehabilitation/restoration**: measures taken to improve degraded or removed ecosystems following exposure to impacts that cannot be completely avoided or minimised. Restoration tries to return an area to the original ecosystem that occurred before impacts, whereas rehabilitation only aims to restore basic ecological functions and/or ecosystem services. Rehabilitation and restoration are frequently needed towards the end of a project's life-cycle, but may be possible in some areas during operation, e.g., after temporary borrow pits have fulfilled their use

If rigorously implemented, avoidance, minimisation and rehabilitation/restoration collectively serve to reduce, as far as possible, the residual impacts that a project has on biodiversity. Often, however, even after their effective application, additional steps will be required to achieve No Net Loss or a Net Gain for biodiversity.

4. **Offset**: measures taken to compensate for any residual, adverse impacts after full implementation of the previous three steps of the mitigation hierarchy. Biodiversity offsets are of two main types: 'restoration offsets' which aim to rehabilitate or restore degraded habitat (not impacted by the project), and 'averted loss offsets' which aim to reduce or stop biodiversity loss in areas where this is predicted to occur.

Restoration actions and, in particular, offsets are often complex, uncertain and expensive. It is thus important to apply the preventative steps in the mitigation hierarchy – **avoidance and minimisation** – as rigorously as possible.

Further Reading:

https://www.thebiodiversityconsultancy.com/approaches/mitigation-hierarchy/

https://www.thebiodiversityconsultancy.com/a-cross-sector-guide-for-implementing-the-mitigation-hierarchy/

10.2.3 AVOID (DESIGN, PLANNING, PRE-CONSTRUCTION)

Location of wind farms and transmission lines is the single most important factor in determining biodiversity impacts. Some locations are much more sensitive than others – e.g. migration bottlenecks, ridges used by soaring birds, and areas of high biodiversity value such as Key Biodiversity Areas. Avoidance is the theme of the sensitivity mapping undertaken in this SEA and reported in section 9.5.

10.2.3.1 RISK SCREENING

Early screening can improve macro-level project site selection and the scoping of priorities for further assessment thus reducing unnecessary biodiversity impacts and project costs in the future[31]. It is an essential part of due diligence in project development.

Screening for wind power projects presents challenges, as the primary risks relate to certain, often highly mobile, species. Information on such species is often not available at a useful spatial resolution in commonly applied screening tools. Some such information, e.g. on vulture movements, is incorporated into the national-level species sensitivity map in this SEA, which gives a broad-brush assessment at the Kenya Bird Map pentad level, a grid square of 9 x 9 km. This is useful for initial screening (see **Error! Reference source not found.**), but the project design phase requires a much closer look at the proposed location and possible alternatives. Investment and design decisions should not be made on the basis of sensitivity maps alone, but need more detailed information and ground-truthing from other sources.

Valuable and often-used screening tools include the Integrated Biodiversity Assessment Tool (IBAT)[32], which makes available verified and up-to-date datasets on nationally and internationally Protected Areas, Key Biodiversity Areas (including Important Bird and Biodiversity Areas), and the IUCN Red List of Threatened Species.

10.2.3.2 STRATEGIC PLANNING

Environmental and social risks to projects can be greatly reduced, along with uncertainty and cost to developers, through integrated strategic land-use planning. Such plans consider potentially conflicting uses and requirements across different economic sectors, as well as social and environmental factors. Typically, they will make a strategic consideration of trade-offs and identify zones for different land-uses.

For wind power specifically, there is a broad array of methodologies for comprehensive evaluation and prioritization of candidate project sites. Tools to analyse the sustainable siting of wind parks often consider land or the capacity constraints, including the potential effects of turbine size, turbine separation and perimeter, the existing wind potential, and the environmental suitability based on other legal requirements (Tsoutsos et al. 2015).

Effective strategic planning requires partnerships are formed between technical experts, broader civil society groups, government and industry. Engagement through formal or informal channels is most effective when trust is established through interaction early in the development process.

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[31] See https://www.thebiodiversityconsultancy.com/wp-content/uploads/2017/01/Biodiversity-Screening-IBN_20170123-FINAL-1.pdf

[32] https://www.ibat-alliance.org/

10.2.3.3 APPROACHES TO AVOIDANCE

Project screening, use of sensitivity mapping, and strategic land-use planning all support *avoidance by site selection* – they help to ensure that projects are placed, all else being equal, in less sensitive locations with relatively low potential biodiversity impacts.

Locations to avoid may include sites of local, regional, and international importance such as national and international protected areas, Important Bird Areas (IBA), Key Biodiversity Areas (KBAs), Alliance for Zero Extinction (AZE) sites, Ramsar sites (Wetlands of International Importance), known congregatory sites, and unique or threatened ecosystems. Avoidance needs to consider not just the site itself (to avoid footprint impacts) but the role of sites in supporting or attracting sensitive species. For example, sites may be known to be important migration routes, wetlands, or staging, foraging, or breeding areas; they may house bat hibernation areas and roosts; or they may contain important topographical features, including ridges, river valleys, shorelines, and riparian areas. These concerns apply equally to transmission lines as to wind turbines. For example, siting a transmission line near a flamingo feeding ground such as Lake Nakuru may not have 'footprint' impact, but may pose a collision risk to night-flying flamingos arriving at or leaving the site.

There is usually limited scope in wind power developments for *avoidance by project design*. Power cables within the wind farm generally are buried, which avoids potential collision or electrocution impacts; while some projects do have above-ground cables, this design is to be discouraged. In some situations, smaller turbines could avoid the risk to species that fly over the site at a particular height. Similarly, lowering the height of short stretches of transmission lines, or burying cables, can avoid collision risk for birds making regular local flights at a particular height, for example from a roosting or feeding area.

Avoidance by scheduling is often considered during construction, where there is a risk of disturbance to species that are seasonally present or sensitive, e.g. during months when they are nesting. Some wind farms have also scheduled curtailment during well-defined migratory seasons when sensitive species are passing through, either using pre-determined dates or based on annual observation of the start and end of migration. Similarly, shut-down scheduling can also avoid impacts on species that are active only during certain times of the day or night – the period after dusk or before dawn for many bats, for example, or the middle hours of the day for vultures. Such measures can be very effective, but come at an obvious economic cost through reduced power generation.

Box 10-2: Suggested use of the SEA sensitivity map for screening

The first step is to identify the pentad(s) overlapped by proposed project sites, and the species and site sensitivity categories for these.

SPECIES SENSITIVITY

Low or Moderate – There is unlikely to be significant risk to sensitive species. Conduct brief site surveillance visits to confirm that risks are likely to be manageable, then consult with experts to plan for baseline surveys.

High – There is likely to be significant risk to sensitive species, though there may be ways to reduce this through minimisation measures and/or avoidance by siting of the project within the landscape. If available, select less sensitive alternatives for further exploration. Otherwise, seek expert advice and design initial scoping surveys to better assess potential risks. If proceeding, recognise that the costs and challenges of managing risk may be much greater than at less sensitive locations.

Very High or Outstanding – There is likely to be elevated risk to sensitive species, and this may be challenging to manage. If at all possible, select less sensitive alternatives for further exploration. Otherwise, seek expert advice and prepare for detailed surveys to assess the actual level of risk and the options for avoidance within the landscape. If proceeding, recognise that costs of survey, monitoring and mitigation, and potential stakeholder opposition, may be considerable; and it may not be feasible to reduce risk to an acceptable level, or to meet No Net Loss/Net Gain targets if required by lenders or corporate commitments.

Bat roost or vulture colony – where a bat roost or vulture colony is mapped within the project pentad, or an adjacent pentad, detailed surveys are likely to be needed to determine potential project impacts and how to manage them. Proximity of a vulture colony in particular indicates a very elevated biodiversity risk, and less sensitive alternative options should be selected if feasible. The risk posed by proximity of a bat roost will depend on the foraging range and behaviour of the species roosting there. Usually, detailed surveys will be required to determine these.

SITE SENSITIVITY

Low or Moderate – There is unlikely to be significant ‘footprint’ risk for biodiversity. Screen using IBAT and land-cover maps to check the location of sensitive sites and natural habitat in relation to the project location options.

High – There is likely to be significant ‘footprint’ risk for biodiversity, but this might be avoided through careful siting of the project within the landscape. Screen using IBAT and land-cover maps to check the location of sensitive sites and natural habitat in relation to the project location options. Conduct brief site surveillance visits if needed to confirm screening results.

Very High or Outstanding - There is likely to be significant ‘footprint’ risk for biodiversity. If at all possible, select less sensitive alternatives for further exploration. Otherwise, screen using IBAT and land-cover maps to check the location of sensitive sites and natural habitat in relation to the project location options. Follow up with site surveys to confirm screening results.

10.2.4 MINIMISE (POST-CONSTRUCTION, OPERATIONAL)

Minimisation actions are to a degree site- and project-specific, because wind turbines and transmission lines vary in size and design, and measures may only be appropriate to a particular species or landscape feature. Successful design and implementation of minimisation measures depend strongly on sound baseline assessment pre-construction and good monitoring during the operational stage. Nevertheless, a suite of mitigation measures are often employed to minimise impacts of wind energy development on birds and bats[33].

10.2.4.1 MINIMISING ATTRACTION OF SENSITIVE SPECIES

In Kenya, a particular hazard may be attraction of vultures and other scavenging birds to carcases of livestock or wildlife on site. Once the food supply has been spotted by one vulture, tens or even hundreds more birds can be attracted in a very short time. Birds are at especially high risk when dropping down to feed, and when moving away again while still heavy with their meal. The presence of livestock and wild ungulates will attract foraging vultures, but this may be difficult to prevent. However, vigilant detection and removal of carcases on- or around the site is usually more practical, if still challenging. This is likely to involve a permanent team of staff, and to require close engagement with local communities.

Carcase removal reduces food supply for vultures, and this is sometimes raised as a concern. In Kenya, however, there is no indication that food supply is a limiting factor for vulture populations.

Build-up of waste on site and the presence of ponds or other water sources can also attract birds at risk, directly or by attracting their prey species. Lattice towers on turbines or met masts provide perches, while turbine lighting can attract insects which in turn bring in both birds and bats. If lighting is required, e.g. for aviation safety, blinking strobe lights with interspersed flashes are likely to be less attractive to animals and are preferred to continuous lights.

10.2.4.2 FEEDING STATIONS TO DIVERT VULTURES

Where vultures or other scavenging birds are frequently foraging over a wind farm site, vulture feeding stations (or ‘restaurants’) could have potential to attract the birds to spend time elsewhere.

However, vultures may not necessarily visit feeding stations. During trials in Pakistan, Gilbert *et al.* (2007) found that many individual birds do not use feeding stations, while those that do show reduced home ranges but may continue to move widely. Feeding stations planned as mitigation measures to divert vultures from wind farms have been tried and failed in Spain and in Jordan (A. Camina, pers. comm.), though there has been greater success in South Africa (R. Simmons, pers. comm.). Feeding

[33] California’s Altamont Pass Wind Resource Area was one of the first extensive wind power developments in the world, with thousands of small turbines (by today’s standards) installed beginning in the 1960s. Shutting down turbines in the winter months, removing poorly-sited turbines and replacing hundreds of smaller, older turbines with fewer newer, larger turbines all contributed to a decline of around 50% in fatalities to four focal species – the American Kestrel, Burrowing Owl, Golden Eagle and Red-tailed Hawk (ICF 2012).

stations may be better used when food elsewhere is scarce. Use of feeding stations may vary seasonally, and with age group, and some feeding stations are rarely or never visited.

Feeding stations may have a variety of drawbacks (e.g. Piper 2004, Cortés-Avizanda *et al.* 2016):

- Changing the ecology and behaviour of the target species' and inter-specific interactions
- Unwanted species may be attracted, including mammalian scavengers; this may have nuisance effects for people and knock-on effects on ecology, e.g. increasing predation on ground-nesting birds or small mammals
- Increasing injuries or deaths from collisions with fences, collisions/electrocutions on power-lines and drownings in reservoirs close to feeding stations
- If carcases are not carefully checked they may themselves contain poisons (e.g. diclofenac or similar harmful non-steroidal anti-inflammatory drugs) that can harm vultures
- Theft of carcases
- Vultures have large appetites – birds may consume 0.5 kg of carrion per day, and more when feeding young. If carcases are being purchased, feeding station costs can be high.

In Kenya, there may conceivably be other challenges:

- Concentrating birds at predictable locations may make them more vulnerable to hunting for belief-based use, if trade in vulture parts becomes more prevalent
- Putting out carcases for vultures could conflict with local cultural values
- We have limited information on vulture movements, but these appear to be quite complex. Without a good understanding of how birds may respond, there is a risk that a poorly-located feeding station could increase the passage rates of birds over a wind farm rather than reduce them. The location of other wind farms or collision risk points also needs to be considered carefully to avoid unintended negative consequences.

Feeding stations are likely to be most effective during breeding seasons, when placed so they can conveniently be accessed by nesting birds. However, there is no guarantee that even breeding birds will use a feeding station, especially if food supply in the wider landscape is plentiful. There is little evidence that vultures are short of food in Kenya. While populations of large wild ungulates and other wildlife have greatly declined in recent decades, so has the number of vultures competing for food – and populations of domestic stock have substantially increased.

It may be valuable to trial feeding stations as a mitigation measure in Kenya, but under close and careful management and monitoring.

10.2.4.3 SHUTDOWN ON DEMAND

This involves strategic, short-term shutdown of turbines to minimise potential impacts. It can be an effective means of mitigation for particular high-priority species at risk. In summary, observers at fixed vantage points scan for priority bird species approaching the wind farm. If an individual bird is on a flight path that is likely to result in collision with a turbine, observers notify the wind farm control centre (e.g. by mobile phone or radio), and the 'risk turbine' (or turbines) is immediately shut down, to be re-started when the risk of collision has passed.

Radar is also used for shutdown on demand, either alone or, increasingly, to support observers. Radar can significantly improve the detection of birds at risk. However, it has the practical drawback that (as yet) it is not possible to identify the bird species from the radar system. Radar may thus be most helpful when there is need to detect the arrival of migrant birds at particular seasons, or where one or two priority species constitute most of the avian traffic. Some radar systems are fully automated, others use a trained operator to support field observers. Radar systems can be costly to purchase.

A number of image detection systems are now also in development and testing (BirdLife International 2015). A camera-based system, Identiflight, was shown to substantially increase detection rates of two eagle species compared to observers at a windfarm in the USA (McClure et al. 2018). Camera-based systems are still evolving and likely to become more effective, and less costly, over time.

Experience shows that shutdown on demand can be effective in minimising impact. In Cadiz, Spain, observer-led shutdown on demand (with a small number of observers) reduced Griffon Vulture (*Gyps fulvus*) mortality by 50%, with an insignificant loss of energy production (de Lucas et al. 2012). A radar-assisted, observer-led approach at Barão de São João wind farm in Portugal in Portugal reduced seasonal mortality of vultures to zero (Tome et al. 2017). Similar approaches in Egypt and Jordan (not yet published) have also produced good results.

Shutdown on demand, whether observer or machine led, is likely to be expensive. It can also take time (experience suggests around two years) to bed in and become effective. There is also an impact on energy production, although this appears to be small — de Lucas et al. (2012) recorded a loss of only c. 0.07% of energy production, although the stopping protocols were concentrated on certain turbines during certain months when birds were on migration.

Shutdown on demand has not yet been tested in Kenya, but at least one wind project plans to implement it soon. In Kenya, cost and the availability of observers currently favours an observer-led approach. This can also help fulfil a project’s social responsibilities to create employment and develop skilled capacity. When setting up an observer-led approach, there is need to consider:

- The number of vantage points needed and their location, so as to cover the site perimeter fully with good viewsheds, and allow detection of birds at risk in good time for turbines to be shut down
- The hours of observation needed – for example, vultures are generally active from mid-morning until early evening
- Observer teams – when turbine blades are turning and the priority bird species are active, observers must be scanning continuously – and this is tiring. Pairing up observers allows for short breaks by one of the team when needed.
- Observation structures – permanent towers of c. 4-5 m height at vantage points will improve the view for sky scanning, and also can be designed to provide some protection from the elements.
- Which species are priorities for shutdown on demand, and which are not – e.g. based on their sensitivity category.

For a large project (by footprint area), the observer team is also likely to be large. The logistics and expense of this, and training requirements, need to be factored into project planning.

10.2.4.4 PAINTED TURBINE BLADES

Attempts to improve birds’ avoidance of collisions by making turbines more conspicuous through alarms, lights or bright colours have so far had little success. However, one approach that may be effective is painting one of the three turbine blades. Research into birds’ visual systems (which are very different to humans') shows that this may help them detect the blades better. Blade painting has been tested at one wind farm in Norway where it has greatly reduced collision rates for White-tailed Eagles *Haliaeetus albicilla.*

10.2.4.5 MICRO-SITING OF TURBINES AND SELECTIVE CURTAILMENT

Baseline surveys, and the EIA process, should identify sensitive areas within the proposed wind farm perimeter. Siting turbines away from these areas can minimise potential impacts. This is particularly useful for bats, which often have relatively small and focused areas where they forage actively, and may be confined to certain habitat types. However, observations of raptors and other birds (such as grassland species that may be displaced by turbines) can also help determine more or less sensitive locations. For example, at Foote Creek Rim, Wyoming, USA, pre-construction surveys showed that about 85% of the raptors flying at likely strike height were within 50 m of the canyon rim edge, and no turbines were established within this zone (Johnson et al. 2002).

In most established wind farms, monitoring has shown that a few 'killer turbines' account for nearly all the fatalities. The location of turbines may be a more significant factor in determining collision rates than the number of birds at risk passing through a wind farm site (de Lucas et al. 2008). However, it can be difficult to identify these problem turbine locations in advance. Behavioural observations can be helpful to identify sites where, for example, raptors may have difficulty gaining height to clear turbine blades, e.g. when the turbine tower is at the top of a long slope.

If specific problem turbines are identified post-construction, an effective mitigation approach may be to curtail operations for those specific turbines at times of the day/night or the year when priority species are active, e.g. in the middle hours of the day for vultures and other large raptor species.

10.2.4.6 TURBINE SELECTION

Turbines are generally becoming larger. This increases the rotor-swept height, and the risk zone for birds and bats. However, larger turbines also generate more electricity, at lower cost and higher efficiency. In many cases, potential biodiversity impacts could be reduced by installing fewer large turbines, rather than many small ones, which also would reduce vegetation clearance needed for installation (World Bank 2015). However, this may not be the case for every site, and a decision should be informed by local site characteristics and bird and bat activity.

10.2.4.7 TURBINE LAYOUT

There are limited data to show how the configuration of turbines affects biodiversity impacts. Behavioural observations of priority species during baseline pre-construction surveys may help to inform layout. Good practice advice is to avoid closely packed turbines, where a bird or bat avoiding one may immediately encounter another, and to maintain corridors in between turbine lines that are aligned with main flight directions. Thus, lines of turbines should run parallel to features such as valleys, rivers, or any known flight path, and not across them.

10.2.4.8 TRANSMISSION LINES

Transmission lines pose a significant collision risk to some bird species. Collisions are mainly with the earth (shield) wire, which is usually thin and raised above the conductors – so is hard for birds to see. Collisions have also been reported with the stay-wires of masts and towers.

Collision risk can be reduced by careful routing, so that transmission lines are not placed across flight routes or near wetlands or other features associated with high avian traffic. Where feasible, collision risk can also be lowered by reducing powerline height, and separating conductors horizontally not vertically, to make a smaller 'target'.

Line marking to increase visibility is a standard 'good practice' mitigation measure that should be applied routinely to transmission lines. Line marking provides substantial but not complete mitigation – studies show an average c. 75% effectiveness (reduction in collision mortality), but this depends on location and species

Many different line-marking devices are available, including aviation balls, spirals and flappers. Many modern designs are 'glow in the dark', so are visible at night – this is important if night-flying species, such as flamingos, are at risk.

All line-marking designs appear to work, so long as they thicken the line by at least 20 cm, over a length of at least 10-20 cm, and are placed at least every 5-10 m along the line. Marking the central 60% of the span is the most important – as fewer collision are recorded near poles.

Contrast appears to be more important than colour of diverters. Mobile devices such as flappers are more visible and effective than stationary ones, but also less durable. In areas of high wind, they tend to fall off or to become stuck in position. For parallel sets of transmission lines, it is more effective to stagger diverters between the lines.

For Kenya, a minimum recommendation is to install spiral diverters every 5 m over at least the middle 60% of the span. Where wind speeds are not sustained and intense, spirals can be alternated with flappers. Where night-flying species may be at risk, flappers should be visible in the dark.

10.2.4.9 BAT-SPECIFIC MITIGATION MEASURES

Wind-turbine cut-in speed is the lowest wind speed at which turbines generate power to the utility system. Bats are more active at low wind speeds. Studies show that slightly raising the turbine cut-in speed can significantly reduce bat mortality (by 44-93%) with only a marginal loss of power output (≤ 1% of annual total) (Arnett et al. 2011, Arnott & Baerwald 2013). For some turbine models whose blades turn at below cut-in speeds without generating power, pitching the blades parallel with wind and stopping rotation below cut-in speeds also significantly reduced bat mortality.

The other promising mitigation measure for bats is acoustic deterrents. These rely on bats' use of ultrasonic calls and echolocation to navigate and forage. Units on turbines that emit broadband ultrasonic noise in similar frequencies to the bats' own calls disrupt echolocation and deter bats from foraging in the area (Arnott & Baerwald 2013). However, ultrasound attenuates rapidly and is heavily influenced by humidity, so this technology is being further developed to make it more effective. This technology has not yet been tested in Kenya. It is also only applicable to Microchiroptera (insect-eating bats that forage through echolocation) not Megachiroptera (larger, fruit-eating 'flying foxes').

10.2.5 RESTORE (OPERATIONAL, DE-COMMISSIONING)

10.2.5.1 RESTORATION OF FOOTPRINT IMPACTS

While restoration is an important component of the mitigation hierarchy, for wind power its role in reducing residual impacts is usually relatively small. This is because 'footprint' impacts, which restoration addresses, tend to be less significant than collision impacts.

Typically, rehabilitation and restoration are implemented towards the end of a project's life-cycle, but may be possible in some areas during operation, e.g., filling out temporary borrow pits after they have fulfilled their use. Similarly, habitat management and maintenance practices could commence post-construction to reduce the risk of attracting collision-prone birds, e.g., by avoiding establishing ponds or waste sites. Where necessary, decommissioning by removal or re-location of high-impact individual turbines within a wind farm is recommended to restore micro-site movement corridors (ICF 2012).

Under de-commissioning and restoration plans, within a pre-determined period following cessation of the operation of the project, the site should be decommissioned and returned, as far as practical and in accordance with a Decommissioning Environmental Management Plan, to its condition before construction started. Monitoring to evaluate the success of site restoration for birds and bats will form part of the plan, which will also set out other site decommissioning and rehabilitation aims and targets including recycling or disposal of all materials from the site, in accordance with end-of-life life cycle assessments, statutory requirements and best practice current at the time of decommissioning (e.g., Sakellariou 2017).

10.2.5.2 REHABILITATION OF INJURED BIRDS

One specific application of restoration is to rehabilitate (and where feasible release) birds, particular raptors, that have been injured by wind turbines or transmission lines. Although many collisions result in fatalities, sometimes disabling injury (e.g. a broken wing) is the result. With specialist attention, such birds can be saved and – if rehabilitation is fully successful – eventually returned to the wild. Where injuries cause permanent damage that prevent a bird being released, rescued birds at specialist centres can be used in education and awareness programmes for conservation, or potentially for captive breeding. Though rehabilitation is a specialised and generally costly exercise, it is well worthwhile for long-lived and threatened birds of prey, such as vultures and large eagles, where every individual is of high value for conservation.

It is recommended that wind farms with potential impacts on raptors or other large birds engage with and support established rehabilitation organisations, i.e. the Kenya Bird of Prey Trust and the Raptor Rehabilitation Trust Kenya, as an element of their restoration efforts. This engagement could be bilateral or (perhaps more valuably) co-ordinated through an industry environmental forum.

10.2.6 OFFSET (PRE-OPERATIONAL, OPERATIONAL, DE-COMMISSIONING)

Biodiversity offsets are conservation actions designed to compensate for unavoidable impacts on biodiversity. Offsets address significant residual impacts after avoidance, minimisation and restoration measures have been applied as fully as possible. Offsets can take the form of **restoring** degraded ecosystems or species populations, or protecting biodiversity from existing threats, thereby **averting loss**.

Although offsets may involve restoration, this should not be confused with the restoration step in the Mitigation Hierarchy. Offsets restore damage that was NOT caused by the project. Similarly, averted loss offsets address threats that are NOT related to the project.

Offsets are generally complex and expensive to implement, and uncertain in their outcomes. Offsets may also be unfeasible for some highly-sensitive biodiversity. **Developers should not rely on offsets as the main focus of their mitigation efforts. It is essential to reduce residual project impacts as far as feasibly possible through rigorous application of avoidance and minimisation** – the preventative steps in the mitigation hierarchy. In practical terms, the first step is to **avoid sensitive locations** when selecting sites for potential wind farms.

Kenya does not at present have a regulatory requirement to offset project impacts for the energy sector, though this policy landscape may change over time – many countries in Africa and elsewhere are developing offset frameworks. However, good international industry practice (GIIP[34]) requires that developers follow the mitigation hierarchy (Box 10-1), where offsets are the final step to address residual negative impacts (Obermeyer et al. 2011). The safeguard frameworks of many lenders, including the major development banks and Equator Principles Financial Institutions, also require offsets in many circumstances. For example, IFC's widely-applied Performance Standard 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources requires projects to achieve no net loss where feasible for natural habitats, and net gain for critical habitats[35]. Where there are unavoidable residual project impacts, achieving no net loss or net gain will require offsets.

10.2.6.1 OFFSET PRINCIPLES

The Business and Biodiversity Offsets Programme (BBOP) has established a set of offset principles[36] (with broad stakeholder agreement) that are regarded as a benchmark of good international practice. Figure 10-1 provides a summary overview and explanation for each of these.

[34] According to the World Bank Group, GIIP is defined as the exercise of professional skill, diligence, prudence, and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity, as well as varying levels of financial and technical feasibility

[35] "Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes" (IFC 2012). IFC's Guidance Note for PS6, revised in 2019, sets out criteria, thresholds and the assessment approach for identifying critical habitats.

[36] The BBOP standard on biodiversity offsets can be found here: https://www.forest-trends.org/publications/standard-on-biodiversity-offsets/

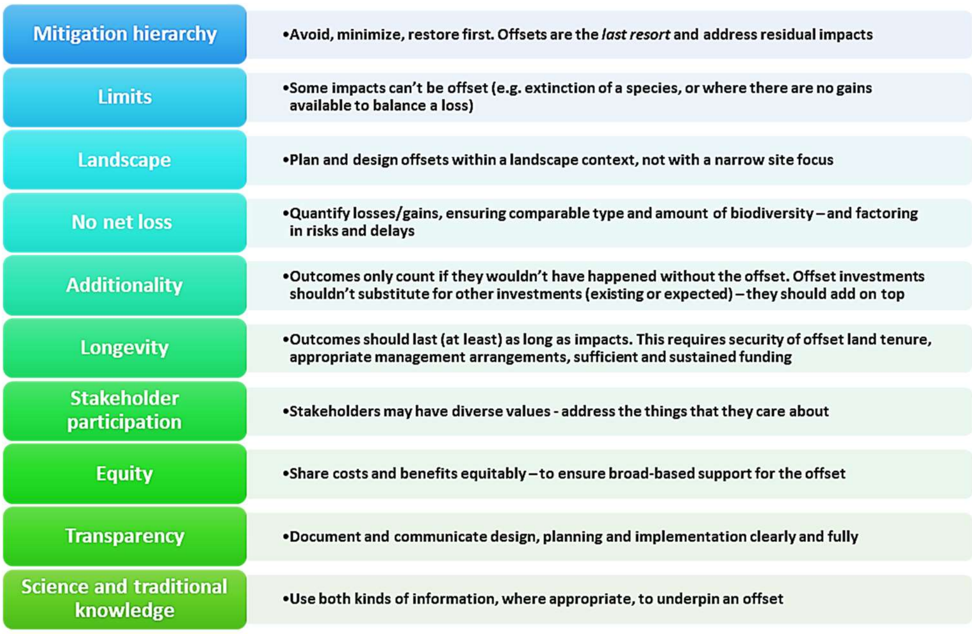

Figure 10-1. Schematic and brief outline of ten good practice principles for biodiversity offsets. For the full statement of principles and verification criteria, see BBOP (2012)

10.2.6.2 PLANNING FOR NET GAIN / NO NET LOSS

Projects that may have impacts on sensitive species (or ecosystems), and that intend to align with international good practice, should start planning early for how to achieve net gain or no net loss. Figure 10-2 shows the key steps required. It is not practical to demonstrate net gain or no net loss for 'biodiversity' as a whole. Rather, the specific features that will be the focus of offset compensation need to be identified. For example, these may be the species that qualify for 'critical habitat' under PS6, or species of particular stakeholder concern because of their conservation status and susceptibility to collisions. The VEC species identified in this SEA as 'high' or 'very high' sensitivity are likely candidates as priority features.

Good information is key for planning and achieving net gain or no net loss. Usually, initial risk assessment surveys should be followed by more intensive surveys focused on priority species – to determine their presence and activity across the course of a year at least. These data can then support the assessment of potential impacts (before mitigation) and residual impacts (after mitigation is applied).

Figure 10-2. Simplified schematic of the key steps in project planning for net gain (or no net loss)

10.2.6.3 OFFSET OPTIONS

Assessment of residual impacts and offset planning should be carried out prior to construction and operations. Preferably, offset actions should be in place before the project begins to operate, to avoid time lags between losses and gains.

The scale of offset required will need to take into account uncertainties in loss/gain estimates. A precautionary approach is required – i.e. assuming that neither mitigation nor offset actions will work perfectly as planned, and that uncertainties may not play out in the project's favour. Estimates and the scale of intervention can be refined over time as more data are collected and as the success (or otherwise) of mitigation actions and offset interventions becomes clearer.

Offsets will obviously need to be chosen according to the priority features identified and residual impacts assessed. For wind farms in Kenya, this SEA suggests that the priority features are most likely to be, in order of likelihood and level of concern:

1. Threatened vulture species
2. Resident birds of prey
3. Migratory soaring birds (including birds of prey)
4. Flamingo, crane and bustard species – which are at particular risk of transmission line collisions
5. High sensitivity bat species

Offsets for these species could either address existing threats ('protection' or 'averted loss' offsets), or attempt to restore habitats and/or reinforce populations by releasing captive-bred individuals ('restoration' offsets).

Research on net gain feasibility for the Kipeto Wind Farm investigated a number of offset options for threatened vultures and resident birds of prey.

For vultures, the most significant threat in Kenya is incidental poisoning, where birds die after feeding at poisoned carcases intended to kill predators. This threat is driven by human-wildlife conflict in the form of livestock predation by wild carnivores.

For raptors more generally, including vultures, a range of threats includes habitat loss, persecution and – increasingly – collision and electrocution on powerlines.

10.2.6.4 OFFSETS FOR VULTURES

Offset approaches for vultures are as yet experimental and untested. Offsets are likely to be expensive and complex, emphasising the need to avoid and minimise impacts as far as feasibly possible.

For Kipeto, the preferred offset option for vultures is an *integrated anti-poisoning programme*. This will be geographically focused on identified 'hotspots' of vulture activity and poisoning risk. The programme has several mutually-reinforcing components:

- Community engagement and awareness raising, through a network of 'vulture scouts' co-ordinated by project field staff in focal areas
- Community development support, linked to anti-poisoning activities
- Livestock protection. e.g. boma reinforcement and improved herding practices, working with established predator protection programmes in southern Kenya
- Rapid detection and response to poisoning incidents, to rescue birds where possible, prevent more birds being poisoned, and collect samples and data for investigation
- Support to Kenya Wildlife Service to respond to poisoning incidents
- Vulture tagging and nest monitoring, to understand birds' movements and behaviour, measure mortality rates, and track population health

Other options were assessed, including direct compensation schemes (paying people not to poison), feeding stations to provide a safe food supply, and captive breeding. For various reasons, these were not found suitable for the main offset effort, though feeding stations (see 10.2.4.2) and captive breeding may play a supplementary role.

10.2.6.5 OFFSETS FOR OTHER RAPTORS

Offset approaches for other raptors are also experimental and as yet untested. Offsets are likely to be expensive and complex, emphasising the need to avoid and minimise impacts as far as feasibly possible.

Several offset approaches may be viable for other raptors, including:

- Conservancy conservation. Supporting the management of conservancies with important raptor populations but limited resources for implementing management plans.

- Retrofitting power lines. Retrofitting poorly-designed distribution lines that are an electrocution threat to raptors, and adding bird diverters to transmission lines that pose a collision threat.

- Rehabilitation and subsequent release of birds injured (away from the project) by e.g. poisoning, electrocution or collision
- Captive breeding and release of highly threatened or fast-declining species.

None of these approaches has yet been well-researched, or piloted, in Kenya, so further work would be required to determine viability and costs, as well as quantification of gains.

10.2.6.6 AGGREGATED OFFSET

In an aggregated offset, one offset project meets the compensation needs of two or more development projects. Gains achieved by the offset are allocated between developments according to an agreed formula, usually in proportion to the amount invested.

The costs and challenges of offset design, setup, implementation and monitoring can be considerable. By investing together in one large project, rather than several small ones, there can be considerable savings and efficiencies for each development.

The species of concern are likely to be similar for many wind farms in Kenya. Offset interventions may also often be at the landscape scale, as with an integrated anti-poisoning programme for vultures. This sets the stage for a potential aggregated approach that could provide better outcomes for developers and for sensitive biodiversity alike.

10.3 SURVEY AND MONITORING

This SEA has outlined mitigation measures appropriate for wind power developments to address their impacts on biodiversity, particularly birds and bats. Besides providing an overview of the framework for the mitigation process, it has recommended specific actions that can be undertaken at every level of the mitigation hierarchy. Pre-construction survey and monitoring is crucial to identify the targets for mitigation and to develop a detailed mitigation plan. Post-construction, it is crucial to track the implementation of planned actions and their outcomes. So far as feasible, monitoring should be performed before and after construction of the wind farm in a comparable way, and include control (reference) areas where possible.

10.3.1 PRE-CONSTRUCTION MONITORING AND ASSESSMENT

Risk assessment surveys should take place as early as possible, ideally in tandem with wind assessments, and should consider the particularities of sites, species, and seasonality. Desktop screening and short reconnaissance visits will help focus the survey effort on species or groups of likely concern, both for footprint and collision risks. In Kenya, at least four surveys are needed in different quarters of the year to capture expected avian seasonality, including the period when Palaearctic migrants are on passage southwards or northwards. Broadly speaking, these periods are: hot dry season (mid December-mid March), long rains and migration season (mid-March to end April), cool dry season (May to mid-October) and short rains and migration season (mid October- mid December). Seasonal patterns vary from year to year, and may be different in some parts of the country – survey scheduling should be adjusted accordingly. Apart from birds, many other species show seasonal patterns – surveys for e.g. amphibians, insects and plants may need to be conducted toward the end of, or shortly after, the rainy seasons to detect species that otherwise are inconspicuous or dormant. Guidance for surveys of birds and bats at wind farms in South Africa (Appendix A.3) is relevant for Kenya and outlines the types of surveys and minimum effort requirements that are standard.

It is important that sampling design and survey techniques are guided by technical experts; they include vantage point surveys, point count surveys, ultrasound acoustic methods and remote-sensing data-gathering techniques, and/or other techniques to understand movement patterns, as appropriate. For bats, besides assessment of feeding and/or roosting habitats both within the project area and in its vicinity, activity surveys should be conducted using hand-held ultrasound bat detectors or static detectors deployed at turbine locations.

The results of risk assessment surveys inform the scope and design of baseline assessment surveys. The focus of these should narrow down to the species or ecosystems identified as potentially high concern, to maximise the value of survey efforts. For instance, there is little point in carrying out further night surveys of nocturnal birds if adequate initial surveys have been done, and no such species have been identified as potential priorities for mitigation.

Survey effort needs to be commensurate with risk. Where there are few, or simple, footprint concerns, risk assessment surveys may be adequate to guide micro-siting of turbines. However, more detailed surveys will often be needed to assess spatial patterns of site utilisation by at-risk species, e.g. to map the distribution of threatened plants or bat species of concern, to locate and map nest sites, or to understand the movement patterns of sensitive bird species. Mapping the location of other topographic, ecological or landscape features may also be important.

In many cases, further vantage point surveys ('skyscanning') for priority bird species will also be required. The aim of these is to determine activity levels (passage rates) that can feed into collision risk modelling (Masden & Cook 2016) to estimate potential impacts. They may also be important for understanding spatial and temporal activity patterns, and response to weather conditions – which may inform micro-siting and future mitigation plans. Typically, vantage point surveys with these aims would be scheduled regularly over the course of a year, to ensure that seasonal variation (within one year, at least) is fully captured. However, the scheduling and diurnal timing of surveys should be adapted to fit the focal species.

Depending on context, it may be useful to employ newer technologies such as camera traps, drones, and satellite tagging. Tagging of birds (or bats) has particular potential to provide more, and more exact, data on behaviour of priority species, including movements and core foraging ranges.

Lastly, where multiple wind farm facilities are located in the same geographical area and near areas of high biodiversity value, wind project developers are encouraged to implement a coordinated approach to surveys and monitoring. In addition to cost effectiveness (e.g., when surveys are jointly planned and executed with shared costs), a common survey methodology and approach lend themselves to cumulative impact assessment.

10.3.2 OPERATION PHASE (POST-CONSTRUCTION) MONITORING

Post-construction biodiversity monitoring during the operational phase on-site aims to confirm or adjust bird or bat impacts predicted in the baseline studies, assess how effectively mitigation measures are being implemented, and to uncover any new or unexpected mortality or other impacts. All this helps to guide adaptive management of the facility.

Where an offset is in place, monitoring will also be needed of implementation progress and of outcomes, relevant to the metrics being used to assess gains and losses.

The design and scale of the operational-phase biodiversity monitoring are guided by site-, species-, and season-specific potential impacts identified during baseline surveys and risk assessments, and by the mitigation measures identified and planned. Therefore, during this phase, monitoring should be designed not only to measure bird and bat fatalities but also evaluate the effectiveness of any mitigation measures implemented such as on-demand shut-down procedures and raised cut-in speeds. Continuous monitoring will inform the need to modify any of the mitigation actions and operational procedures proposed in order to enhance their effectiveness.

Of particular importance for post-construction monitoring are carcase searches. Careful sampling design is needed to ensure that the resulting estimates of bird and bat injury and/or fatality rates are robust. Designs should incorporate statistical principles of sampling and randomisation in case the entire facility (i.e., all turbines) cannot be searched, and correction for factors that might influence carcase detection such as target species, searcher efficiency and removal by scavengers.

Monitoring during this phase may also include further surveys of the use and movement patterns of birds and bats through the wind facility to supplement baseline data gathered pre-construction, and augment carcase search data. Where a project is implementing observer-led shutdown on demand, observers can collect valuable monitoring data on bird activity alongside watching for and averting potential collisions.

10.4 ROLES, RESPONSIBILITIES AND INSTITUTIONAL CAPACITY

Governing framework for the energy sector in Kenya contains a diverse array of laws, policies and regulations, and the government has shown support for renewable energy projects through formulation of policies and strategies to encourage uptake of renewable energy as an option in the country's energy mix. Analysis of the major policy instruments point towards government commitment and efforts to promote renewables at different scales: off-grid, mini-grids and on-grid. Yet, these efforts may not bear the desired fruits if they are not supported by requisite capabilities at individual and institutional levels. Indeed, some of the key policy documents recognise the lack of skills and capabilities to be limitations to renewable energy development.

It is the responsibility of the Ministry of Energy to oversee implementation of the principles, guidance and spirit of the EMMP proposed in this plan-level SEA for the wind sector in Kenya by independent developers. The National Environmental Management Authority (NEMA) has the overarching mandate of making sure that all the actions are carried out in accordance to the appropriate laws of the land, and in partnership with the requisite stakeholders. Ultimately, the successful implementation of the actions proposed in this EMMP is however dependent on their cascading down to specific project ESIAs.

Kenya is fortunate in having substantial technical capacity for biodiversity survey and conservation implementation. There already exists a skilled pool of consultants familiar with the regulatory and permitting requirements related to environmental impact assessment in Kenya. However, there is much less exposure to good international practice in relation to risk assessment, identification of priority species, cutting-edge mitigation methods, residual impact assessment, loss/gain accounting, fatality monitoring and offset design and implementation. These skills will be needed if the measures outlined in earlier sections are to be effectively implemented, so as to prevent negative cumulative impacts on a suite of sensitive species.

Developments that need to implement significant mitigation measures (such as shutdown on demand and carcase clearance) will need to recruit and train appropriate teams to carry out this work. While there is a sizeable pool of potential recruits (with experience as observers or willingness to learn), there are far fewer with the skills and experience to provide relevant training or to lead on-site teams. There is need to train trainers for this purpose.

Although developers sometimes implement their own offsets, it is more usual – and likely to be more effective and efficient – for implementation to be carried out by conservation NGOs, government agencies, or both. Overall, there insufficient capacity in both civil society and national parastatals for the planning, design, and effective implementation of offsets; and still less in county-level government. Furthermore, offsets are likely to involve some innovative approaches, or combinations of approaches, that typically involve a broad range of organisations and communities in different roles, which requires a multidisciplinary and multi-institutional approach. It will be valuable to learn from the experience of countries that have more mature offset systems (policies and institutions) and to ensure that lessons are passed on through formal and informal means as additional offsets are planned and implemented for wind power projects in Kenya.

11 CONCLUSIONS

11.1 LIMITATIONS OF THIS ASSESSMENT

This SEA represents a first, and ambitious, effort to assess biodiversity sensitivity in relation to wind power potential and planned developments in Kenya.

The assessment has brought together a large amount of existing data, much of it not previously compiled, and generated considerable new data through field surveys and additional vulture tagging. It has developed novel ways of categorising and combining biodiversity components to develop overall sensitivity maps. It has been informed throughout by the best available national expertise, by international experience in sensitivity mapping and biodiversity analysis, and by input from knowledgeable stakeholders and potential end-users in government, industry and civil society.

The results represent a major advance in our understanding of the environmental risks of wind power development in Kenya, and of the opportunities for safe development that will minimise biodiversity impacts.

The substantial datasets that underpin the results give confidence that the broad findings are robust. Yet they should still be interpreted with caution, especially when assessing risk for individual wind farm locations. Ground-truthing through additional surveys and information collection will be essential before decisions are made on specific development projects.

A number of information gaps remain, and should be the subject of future research and data collection:

- Concentration routes, stopover points, flight height and other behaviour of long-distance migrants. These include both Palaearctic migrants, intra-tropical migrants moving within Africa, and species making frequent long-distance (> 100 km) movements within the region. Birds may migrate by day (raptors, storks, soaring birds) or by night (flamingos, many species of passerines or near-passerines). Better information is needed to assess the level of risk and how this varies geographically and seasonally for different species. Migration along the north coastal strip has been flagged as a particular gap in knowledge, possibly giving a misleadingly low categorisation of risk for some pentads with economic wind in this area.
- Vulture movements. Satellite tagging means we know far more than even a few years ago about where vultures are moving and spending time. Some gaps remain – tagged birds are not foraging over the north coast, yet there are many vulture observations there. This indicates that further tagging is needed to ensure we have a comprehensive picture, and can also improve understanding of seasonal patterns and response to weather and wind conditions.
- Vulture and raptor nest sites. We have an incomplete picture at present and more comprehensive surveys and mapping, and ongoing monitoring, are needed.
- Intrinsic collision risk. For many Kenyan bird species, susceptibility to collision has been inferred from observations from elsewhere, and trait modelling using these empirical data. As wind farms become operational, data on actual collision frequency will be invaluable to refine and improve these estimates for Kenyan bird species. Ideally, those data will be combined with behavioural observation and tracking the responses of tagged birds moving through turbine fields.

- Information on bats. Kenya is fortunate to have a very active group of bat researchers who have collected large amounts of valuable data in recent years on this previously neglected group of flying mammals. However, large data gaps remain regarding basic species distribution, roost sites, movements and behaviour (including flight heights), seasonal patterns, and susceptibility to collisions. In contrast to bird VECs, there are few highly threatened bat species in Kenya – as yet – but the limited knowledge of this group means that declines could be happening without yet being observed. Co-ordination of research and survey efforts, and pooling data, would be particularly useful for bats.

11.2 KEY FINDINGS

- There is a positive policy environment for wind power development in Kenya, and a large number of planned and potential developments are in the pipeline.
- Planning for wind power development has focused on predicted energy needs and the desired energy mix. Environmental considerations have been incorporated only through project-level impact assessment and permitting.
- Wind power can potentially have significant cumulative impacts, especially on wide-ranging or migratory, collision-prone bird and bat species. There is thus the potential for conflict between sectoral policy aims for energy and environment.
- Mapping of biodiversity sensitivity against the wind resource shows that there are large areas of economic wind potential in Kenya where biodiversity risk is likely to be low or manageable. Only 17% of economic wind area pentads are classed as Very High or Outstanding sensitivity for species.
- Mapping of biodiversity sensitivity against the wind resource shows that there are large areas of economic wind potential where biodiversity risk is likely to be low or manageable.
- The bulk of these lower-risk areas of economic wind are in counties in northern and eastern Kenya. Other counties also have areas of good wind resource, but these are relatively small and many pentads show **very elevated risk** (i.e. Very High or Outstanding sensitivity for species and/or sites). Only a few economic wind pentads in Kajiado, Meru and Laikipia have lower biodiversity risk, while all economic wind pentads in Narok are classed as **very elevated risk** for biodiversity.
- Lower-risk areas of economic wind may not have the best wind resource in the country, and may require investment in infrastructure (new roads and transmission lines) in order for developments to be viable.
- Further research would be needed to bring together technical, economic, social and environmental factors to identify the overall 'best bet' locations for future wind development in Kenya. This SEA can inform the environmental component of such a study.
- Species risk (collision-focused) is generally much more widespread and more significant than site risk (footprint-focused) within the economic wind area in Kenya, though this is a general conclusion and varies with locality. This is unsurprising, given that concerns over wind power's potential biodiversity impacts focus mainly on fatalities of sensitive species through collisions, with turbines or transmission lines.
- The majority of current, planned or potential wind power projects are in locations where potential biodiversity impacts should be low, or manageable, based on sensitivity mapping.
- However, a number of current, planned or potential wind power projects are in pentads with **very elevated risk.** These include at least one development in each of Narok, Nakuru, Laikipia and Isiolo counties, three in Marsabit and seven in Kajiado. Meru and (especially) Isiolo also have developments where there are known bat or vulture colonies in at least one adjacent pentad.

- A Potential Biological Removal (PBR) analysis (estimating the number of individuals that can be subject to human-induced mortality without significant population effects) highlights a number of Kenyan species, including threatened vultures, that may be highly susceptible to cumulative impacts of wind farms. For these species, additional wind farm fatalities need to be reduced to as close to zero as possible to prevent negative effects on populations.

11.3 RECOMMENDATIONS

The following are key recommendations emerging from this assessment. For each, there is an indication of where the recommendation is addressed, in terms of lead or supporting institutions.

11.3.1 PLANNING

- Use the sensitivity mapping presented in this report for risk-screening planned and potential developments for biodiversity risk (bearing in mind that ground-truthing will be needed to confirm the level of risk). Recommended actions to take, according to the level of risk, are outlined in Box 10-2Box 10-2. *Who*: Wind power developers, Ministry of Energy/energy parastatals and NEMA.
- There is particular need to make the findings available and accessible to county-level governments and planners. An initial step could be a workshop to present and discuss results with development and environment planners from counties with high wind energy potential (stakeholders who have had relatively limited involvement in the exercise so far). *Who*: Ministry of Energy, NGOs, USAID/Power Africa program.
- Current, planned or potential wind energy developments in pentads with elevated (Very High or Outstanding sensitivity; Table 9-5) may be at particular risk of significant biodiversity impacts. Planned and potential developments need to ensure that baseline survey efforts are adequate to assess the actual risk, and consider re-location if this is found to be high. Developments that are operational or in construction should review their baseline and monitoring data to assess actual risk levels and impacts, reinforce survey effort if necessary to obtain robust information, and plan for appropriate mitigation to minimize and if required offset impacts. *Who*: Wind power developers.
- Consider a follow-up exercise to incorporate technical, economic and social considerations, as well as biodiversity, into a spatial strategic plan for wind power development in Kenya that explicitly identifies and addresses trade-offs. This will require a broad partnership between technical experts, NGOs, government and industry. *Who*: USAID/Power Africa Program, Ministry of Energy.

11.3.2 MITIGATION AND MONITORING

- Introduce a no net loss/net gain project requirement for the highly sensitive biodiversity features, aligned with international good practice benchmarks such as IFC's Performance Standard 6. Some projects are expecting to meet this requirement because of their financing requirements or corporate commitments, but others are not: this requirement would help to level the playing field, and to protect vulnerable species from cumulative impacts at population level. *Who*: NEMA, ERC.
- Consider collaboration to design and implement one or more aggregated offsets to address impacts on a shared suite of sensitive species impacted by wind power. This will improve efficiency and effectiveness, and reduce the time and cost of design, set up and monitoring. *Who*: Wind power developers, working with the conservation community.
- Consider collaboration for joint industry support of rehabilitation and (where feasible) release of raptors and other large birds. *Who*: Wind power developers, working with the Kenya Bird of Prey Trust and the Raptor Rehabilitation Trust Kenya.
- Develop good-practice national guidelines for mitigation and monitoring of wind power impacts to biodiversity, as a benchmark for wind power developments. *Who*: Wind power developers (industry environmental forum – see 11.3.4), NGOs (wind-power forum – see 11.3.4).

- Institute a permitting requirement for a robust biodiversity monitoring programme (scaled to assessed levels of risk) at all newly approved wind farms, to continue throughout operations. This should include thresholds that if exceeded trigger immediate mitigation measures (such as shut-down of 'problem' turbines). Monitoring data should be compiled and submitted regularly to an independent monitoring body (below). *Who*: NEMA.

11.3.3 CO-ORDINATION

- Institute an industry environmental forum among wind developers in Kenya, in order to share experience, information and learnings; promote good practice; and interface with regulators, government and the conservation community. *Who*: Wind power developers.
- Develop agreements and mechanisms to share biodiversity survey and monitoring data for wind power developments and offsets, and to standardise data-collection protocols, in order to improve mitigation approaches, cross-project learning and assessment of cumulative impacts. *Who*: Wind power developers.
- Institute a wind-power forum within the conservation, research and consultant community, in order to share experience, information and learnings; promote good practice; and interface with regulators, government and industry. *Who*: the Kenya Bird Conservation Consortium, bird and bat researchers, environmental consultants working in the wind sector.
- Create an independent biodiversity monitoring and advisory body for wind power in Kenya. This would compile and report on monitoring data, update the information base, advise on proposed new wind farms, review the biodiversity elements of EIAs, track technological developments and the evidence base for mitigation measures, and co-ordinate training. This body would be funded by a subvention from planned and operational wind farms, scaled by size, as a permitting requirement. *Who*: NEMA, in collaboration with researchers, NGOs, developers and Ministry of Energy.

11.3.4 INFORMATION

- Agree on a data repository (ideally the independent biodiversity monitoring and advisory body recommended above) and platform to make mapping and the underlying data (where feasible) freely available. Develop mechanisms to update sensitivity mapping regularly with new data and analyses. *Who:* USAID/Power Africa Program, Kenya Bird Conservation Consortium.
- Institute a co-ordinated research and data management program to improve the biodiversity information base and fill identified data gaps in sensitivity mapping. This should include surveys to ground-truth lower-risk areas of economic wind where there is poor biodiversity data, to confirm that risk categorisation is based on reality rather than inadequate data. *Who*: National Museums of Kenya, Kenya Bat Working Group, other researchers, The Peregrine Fund, Nature Kenya Bird Committee, BirdLife International.

11.3.5 CAPACITY

- Develop train-the-trainer programs for leaders of on-site biodiversity mitigation teams at wind power developments. *Who*: National Museums of Kenya, The Peregrine Fund, Nature Kenya.
- Develop training programs for national consultants in understanding and implementing good international practice for wind power, in relation to among others risk assessment, identification of priority species, cutting-edge mitigation methods, residual impact assessment, loss/gain accounting, fatality monitoring and offset design and implementation. *Who*: Environment Institute of Kenya, development banks, USAID/Power Africa Program.

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13 APPENDICES

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A.2 LIST OF WIND POWER PROJECTS AND ASSOCIATED PENTAD SENSITIVITIES

No.	Source	Pentad ID	County	Project	MW	Status	SP	ST	VER?	Vult	Bat	VEC species score	VEC sites score	Latitude	Longitude
1	LCPDP	0120_3635	Kajiado	Ngong 1 - PhaseI&II	25	Operational	Very High	Medium	Y			881	3	-1.380555	36.635553
2	LCPDP	0245c3640	Marsabit	Lake Turkana - Phase I	310	Operational	High	Outstanding	Y			456	11	2.749998	36.716667
3	LCPDP	0140_3640[a]	Kajiado	Kipeto - Phase I&II	100	Advanced	Outstanding	Low	Y	Y		4165	1	-1.749998	36.75
4	LCPDP	0110_3630	Kiambu	Aperture	50	Advanced	High	Low				605	1	-1.201991	36.567597
5	LCPDP	0135_3635	Kajiado	Chania Green	50	Advanced	Very High	Low	Y	Y		1530	1	-1.630515	36.635364
6	LCPDP	0120_3635	Kajiado	Ngong 1 - Phase III	10	Advanced	Very High	Medium	Y			881	3	-1.380555	36.635553
7	LCPDP	0220_4040	Lamu	Electrawinds Bahari	50	Advanced	Medium	Low				412	0	-2.415423	40.742221
8	LCPDP	0125_3635	Kajiado	Ol-Danyat Energy	10	Advanced	High	Medium				794	2	-1.49733	36.627907
9	LCPDP	0125_3635	Kajiado	Prunus	51	Advanced	High	Medium				794	2	-1.442136	36.657038
10	LCPDP	0020c3735	Kajiado	Meru-KenGen-AfD Phase I	80	Advanced	High	Low		Y	Y	660	0	0.329722	37.591667
11	LCPDP	0220_4040	Lamu	Electrawinds Bahari Phase 2	40	Advanced	Medium	Low				412	0	-2.415423	40.742221
12	LCPDP	0020c3735	Kajiado	Meru-KenGen-AfD Phase II	100	Early	High	Low		Y	Y	660	0	0.329722	37.591667
13	LCPDP	0020c3735	Kajiado	Meru-KenGen-AfD Phase III	220	Early	High	Low		Y	Y	660	0	0.329722	37.591667
14	LCPDP	0045_3630	Nakuru[d]	Aeolus Kinangop	60	Paused	High	Very High	Y			519	10	-0.827786	36.555353
15	LCPDP	0245c3805	Marsabit	Marsabit Phase I - KenGen	300	Early	Very High	Very High	Y			1396	9	2.707886	38.096475
16	Others	0020_3510	Kericho	Bluesea-Belgut	7	Unknown	High	Medium				440	2	-0.36299	35.228415
17	Others	0035_3410[b]	Homa Bay	Bluesea-Lambwe Valley	60	Unknown	High	High				479	7	-0.666667	34.25
18	Others	0015c3730	Meru	Bluesea-Meru	40	Unknown	High	Medium		Y		604	2	0.216135	37.510075

No.	Source	Pentad ID	County	Project	MW	Status	SP	ST	VER?	Vult	Bat	VEC species score	VEC sites score	Latitude	Longitude
19	Others	0135_3635	Meru	Esidai-Frontier Market Energy	50	Mid-stage	Very High	Low	**Y**	Y		1530	1	-1.612225	36.586278
21	Others	0010c3745	Meru	Gulf Energy	100	Unknown	High	Medium				510	2	0.134064	37.793232
22	Others	0310c3725	Marsabit	Ignite Global-Kalacha	50	Unknown	Medium	Low				407	0	3.141049	37.420793
23	Others	0020c3735	Meru	WindLab Meru	80	Early	High	Low		Y	Y	660	0	0.329722	37.591667
24	Others	0350_3940	Kilifi	Mombasa Cement-Vipingo	36	Unknown	Medium	Medium			Y	405	3	-3.88229	39.740674
25	WindForce	0150c3645	Samburu	Baragoi	[70]	Unassigned	Medium	Medium				408	2	1.785109	36.787326
27	WindForce	0105c3925	Wajir[c]	Habasweni	[70]	Unassigned	Very High	Low	**Y**			1336	1	1.009044	39.492256
28	WindForce	0130_4000	Tana River	Hola	[70]	Unassigned	Low	Medium				336	2	-1.503322	40.027409
29	WindForce	0140c3745	Marsabit	Laisamis	[70]	Unassigned	Outstanding	Medium	**Y**	Y		5562	3	1.596199	37.806115
30	WindForce	0105_3530	Narok	Narok	[70]	Unassigned	Very High	High	**Y**			1491	8	-1.100268	35.530564
31	WindForce	0240c3740	Marsabit	Maikona	[70]	Unassigned	High	Low				504	0	2.590351	37.672085
32	WindForce	0300_4010	Kilifi	Ngomeni	[70]	Unassigned	Medium	Low				389	1	-3.022958	40.173862
34	ERC	0215_4050	Lamu	Lamu	90	Unknown	Low	Low				351	1	-2.27883	40.885467
35	ERC	0000_3635	Laikipia	Suguroi	2	Unknown	High	Low				532	0	-0.010041	36.630728
36	ERC	0000_3630	Laikipia	Ndaragua	2	Unknown	Very High	Very High	**Y**			1412	10	-0.055262	36.526787
37	ERC	0025_3505	Kericho	Kapchebet Tea Factory	2	Unknown	High	Medium				450	2	-0.421022	35.130635
38	ERC	0130_3640	Meru	Olchoro Onyore	26	Unknown	Very High	Low	**Y**	Y		1546	1	-1.51667	36.7
39	ERC	0305_4005	Kilifi	Mambrui	100	Unknown	High	Medium				549	2	-3.095108	40.150399
40	ERC	0020_3430	Homa Bay	Rieny Hills	20	Unknown	High	Medium				492	2	-0.388683	34.521418
41	ERC	0040c3520	Uasin Gishu	Sergoit	40	Unknown	High	Medium				494	2	0.646126	35.411517
42	ERC	0250_3730	Meru	Oloitokitok	50	Unknown	Very High	Low	**Y**			1760	0	-2.914688	37.506339

No.	Source	Pentad ID	County	Project	MW	Status	SP	ST	VER?	Vult	Bat	VEC species score	VEC sites score	Latitude	Longitude
43	ERC	0025_3940	Garissa	Garissa	100	Unknown	Medium	Low				405	0	-0.456829	39.686385
44	ERC	0220_4040	Lamu	Mpeketoni	90	Unknown	Medium	Low				412	0	-2.377773	40.695594
45	ERC	0015c3750	Meru	Michimikuru	30	Unknown	Medium	Medium				425	2	0.194998	37.853745
46	ERC	0340_3905	Kwale	Taru Ranch	100	Unknown	Medium	Low				401	0	-3.694792	39.145765
47	ERC	0140_3935	Tana River	Tana River	50	Unknown	Low	Low				268	1	-1.695966	39.625392

[a] Also 0140_3645

[b] Also 0035_3415

[c] On border with Isiolo County

[d] On border with Nyandarua County

MW: Net capacity in MW. Capacity for WindForce sites is not specified, and listed as average of all other developments (70 MW)

SP = species VEC sensitivity category

ST = site VEC sensitivity category

VER? = Very elevated risk (species and/or site sensitivity is Very High or Outstanding)

Vult = Presence of vulture colony in adjacent pentad

Bat = Presence of bat colony in adjacent pentad

For projects overlapping more than one pentad, the pentad with the highest sensitivity overall has been listed.

A.3 KEY GUIDANCE DOCUMENTS FOR ASSESSING, MITIGATING AND MONITORING THE BIODIVERSITY IMPACTS OF WIND FARMS

General

Conservation Evidence - https://www.conservationevidence.com/
Compiles and assesses available evidence for the effectiveness of conservation interventions, including minimisation of wind power impacts.

Convention on Migratory Species (CMS) 2015. *Renewable Energy Technologies and Migratory Species: Guidelines for Sustainable Deployment*. Bonn, Convention on Migratory Species.
https://www.unep-aewa.org/sites/default/files/document/stc10_24_renewable_energy_guidelines.pdf

Cross-sector Biodiversity Initative (CSBI) and The Biodiversity Consultancy 2015. *A cross-sector guide for implementing the Mitigation Hierarchy*. London, CSBI.
http://www.csbi.org.uk/our-work/mitigation-hierarchy-guide/
Detailed explanation and guidance on implementation of the mitigation hierarchy in development projects.

Gartman, V., Bulling, L., Dahmen, M., Geißler, G. & Köppel, J. 2016 Mitigation measures for wildlife in wind energy development, consolidating the state of knowledge — part 1: planning and siting, Construction. *Journal of Environmental Assessment Policy and Management* 18: 1650013.
https://www.worldscientific.com/doi/pdfplus/10.1142/S1464333216500137

Gartman, V., Bulling, L., Dahmen, M., Geißler, G. and Köppel, J., 2016. Mitigation measures for wildlife in wind energy development, consolidating the state of knowledge — part 2: operation, decommissioning. *Journal of Environmental Assessment Policy and Management*, 18: 1650014.
https://www.worldscientific.com/doi/pdf/10.1142/S1464333216500149

Strickland, M.D., Arnett, E.B., Erickson, W.P., Johnson, D.H., Johnson, G.D., Morrison, M.L., Shaffer, J.A. and Warren-Hicks, W. 2011. *Comprehensive guide to studying wind energy/wildlife interactions*. *Prepared for the National Wind Coordinating Collaborative, Washington, DC, USA*, *5*, pp.315-324.
https://www.batcon.org/pdfs/wind/National%20Wind%20Coordinating%20Collaborative%202011_Comprehensive%20Guide%20to%20Studying%20Wind%20Energy%20and%20Wildlife%20Interactions.pdf

U.S. Fish and Wildlife Service (USFWS) 2012. *Land-based Wind Energy Guidelines*. Washington, D.C., USFWS.
https://www.fws.gov/ecological-services/es-library/pdfs/WEG_final.pdf

World Bank 2015. *Environmental, Health and Safety Guidelines for Wind Energy*, August 7, 2015. Washington, D.C., World Bank Group.
https://www.ifc.org/wps/wcm/connect/2c410700497a7933b04cf1ef20a40540/FINAL_Aug+2015_Wind+Energy_EHS+Guideline.pdf?MOD=AJPERES

Bats

Aronson, J., Richardson, E.K., MacEwan, K., Jacobs, D., Marais, W., Aiken, S., Taylor, P., Sowler, S. and Hein, C. 2014. *South African good practice guidelines for operational monitoring for bats at wind energy facilities.* South African Bat Assessment Advisory Panel.
http://sabaa.org.za/documents/201407_SAGPGforOperationalMonitoring_1stEdition.pdf

Sowler, S., Stoffberg, S., MacEwan, K., Aronson, J., Ramalho, R., Forssman, K. and Lötter, C. 2017. *South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments-Pre-construction*. Edition 4.1. South African Bat Assessment Association. http://sabaa.org.za/documents/20171003_SAGoodPracticeGuidelines.pdf

Rodrigues, L. *et al*. 2014. *Guidelines for Consideration of Bats in Wind Farm Projects*. EUROBATS Publication Series No. 6. Bonn, UNEP/EUROBATS https://www.eurobats.org/sites/default/files/documents/publications/publication_series/pubseries_no6_english.pdf

Scottish Natural Heritage, Natural England, Natural Resources Wales, RenewableUK, Scottish Power Renewables, Ecotricity Ltd, University of Exeter & Bat Conservation Trust 2019. *Bats and Onshore Wind Turbines: Survey, Assessment and Mitigation.* Dundee, Scottish Natural Heritage. https://www.nature.scot/sites/default/files/2019-01/Bats%20and%20onshore%20wind%20turbines%20-%20survey%2C%20assessment%20and%20mitigation.pdf

Birds

Birdlife International 2015. *Review and guidance on use of “shutdown-on-demand” for wind turbines to conserve migrating soaring birds in the Rift Valley/Red Sea Flyway*. Regional Flyway Facility. Amman, Jordan. http://migratorysoaringbirds.undp.birdlife.org/sites/default/files/msb_guidance_shutdown_on_demand.pdf

BirdLife International n.d. *Migratory Soaring Birds Project Wind Energy Guidance v.1 Developers & consultants*. Amman, Jordan, Regional Flyway Facility. http://migratorysoaringbirds.undp.birdlife.org/sites/default/files/factsheet%20Wind%20Farm%20Developer%20new%20logo%20PR.pdf

Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D. and Smit, H.A. 2015. *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa*. 3rd edition. Johannesburg, Endangered Wildlife Trust & BirdLife South Africa. https://tethys.pnnl.gov/sites/default/files/publications/Jenkins-et-al-2015.pdf
Includes recommendations on baseline survey effort, for a suite of species of concern similar to Kenya.

Prinsen, H.A.M., Smallie, J.J., Boere, G.C. & Píres, N. (compilers) 2012. *Guidelines on How to Avoid or Mitigate Impact of Electricity Power Grids on Migratory Birds in the African-Eurasian Region.* AEWA Conservation Guidelines No. 14, CMS Technical Series No. 29, AEWA Technical Series No. 50, CMS Raptors MOU Technical Series No. 3, Bonn, Germany. https://www.unep-aewa.org/en/publication/aewa-conservation-guidelines-no-14-guidelines-how-avoid-or-mitigate-impact-electricity

Scottish Natural Heritage 2014. SNH Guidance. *Recommended bird survey methods to inform impact assessment of onshore wind farms.* Battleby, Scottish Natural Heritage. https://www.nature.scot/recommended-bird-survey-methods-inform-impact-assessment-onshore-windfarms

A.4 DETAILED TORS FOR THE WIND POWER AND BIODIVERSITY SEA

Based on the NEMA-approved ToRs in the Scoping Report, the SEA team was tasked to undertake a detailed SEA study for wind power development in Kenya, focussing on potential impacts on biodiversity, mainly birds and bats. These are the focus of this SEA due to growing evidence of threats to flying species from wind turbines and associated transmission lines. This included the following activities:

UNDERTAKING THE DETAILED SEA STUDY

I. Baseline data collection: In addition to desk research, the SEA team will collect additional baseline data from the field, to enable assessment of the objectives and indicators identified in the Scoping Report including:
   a. Physical environment: including the relevant aspects of climate, geography and topography
   b. Biological environment: including relevant aspects of biodiversity, ecology and conservation such as endangered species, protected ecosystems, habitats and sites
   c. Socio-cultural and socio-economic conditions: including relevant aspects of cultural heritage, landscape, human health, social-economic aspects, infrastructure, tourism and agricultural development.

II. Situation analysis: The SEA team shall interpret the environmental baseline data collected to understand the existing environment and to identify the trends, and environmental opportunities and constraints in relation to wind power development as relates to birds and bats

III. Identify and predict impacts and evaluate their significance: The SEA team will identify all the possible impacts on key biodiversity (birds and bats) associated with wind power development and determine their level of significance

IV. Compare alternatives: Any potential alternatives for wind power development trajectories will be compared to identify the preferred and to flag any alternatives that pose significant biodiversity threat. With a focus on birds and bats, the comparative evaluation of alternatives will highlight potential irreversible effects or irreplaceable loss of natural capital, as well as risks to social and ecological systems. To achieve this, the SEA will develop scenarios which will focus on:
   a. Identification of the strategic issues associated with wind power including critical advantages and key concerns
   b. Representation of the current and predicted state of conservation for the target biodiversity (birds and bats) with a description of the key driving forces
   c. Identification of key uncertainties that could lead to a different predicted future state
   d. Outlining possible futures based on the key driving forces and uncertainties identified.
   e. The 'worst case' and the 'do-nothing' scenarios will be identified to serve as benchmarks for the above evaluation. Options and alternatives that are illegal, ridiculous, not feasible, or unacceptable to society will not be considered. The SEA shall focus on evaluating feasible, reasonable options and alternatives that work towards achieving Kenya's main wind energy goals

V. Identifying measures to enhance opportunities and mitigate adverse impacts: the overarching goal of this SEA is to enhance any positive opportunities and minimise any negative risks of wind power development. The positive opportunities will generally promote the achievement of the SDGs and other positive development goals and objectives. The aim is to develop "win-win" situations where multiple, mutually reinforcing gains can strengthen the economic base, provide equitable conditions for all, whilst protecting and enhancing the conservation of birds and bats in Kenya. Where this is not possible, trade-offs must be clearly documented to guide decision makers. To this end, the SEA team will therefore identify measures to enhance opportunities and mitigate adverse impacts of wind power development – mainly turbines and associated transmission lines.

QUALITY ASSURANCE OF THE DRAFT SEA REPORTS

Before submitting the Draft SEA report to NEMA, the SEA team will ensure quality assurance of the SEA using the same checklists as the internal and external reviewers will use. Initial drafts will be reviewed by all consortium partners and by technical experts in Power Africa, then approved for submission by the Ministry of Energy as Plan owner.

SUBMIT DRAFT SEA REPORTS TO NEMA

The SEA team will submit ten (10) hard copies and one (1) electronic copy for each of the Draft SEA Report (with a non-technical summary) to NEMA, along with the designated SEA Submission Form.

FACILITATE PUBLIC REVIEW

Upon submission of the Draft SEA Reports to NEMA, the SEA team will ensure that the Ministry of Energy publishes two notices regarding the Draft SEA Report, each one week apart in both the Kenya Gazette and a newspaper with a nationwide circulation.

PARTICIPATE IN THE FINAL REVIEW OF THE DRAFT SEA REPORTS

The SEA team will be expected to participate in the final review of the Draft SEA Report organised by NEMA in order to note down all the comments.

REVIEW THE DRAFT SEA REPORTS

The SEA team will review the draft SEA Reports based on the stakeholder comments received during final review of the report.

FACILITATE A VALIDATION WORKSHOP

The SEA team will organise and facilitate a validation workshop (s) in coordination with NEMA and the Ministry of Energy to engage key stakeholders in reviewing and validating the corrected SEA Report.

PREPARE THE FINAL SEA REPORTS

The SEA experts will prepare the Final SEA Report, incorporating all stakeholder comments from the validation workshop and ensure that it is endorsed by the Ministry of Energy.

SUBMIT FINAL SEA REPORTS TO NEMA

The SEA team will submit, on behalf of MoE, five (5) hard copies and one (1) electronic copy of the Final SEA Report to NEMA along with the SEA Submission Form 17 r42.

OBTAIN APPROVAL OF THE SEA REPORT

The SEA team will follow up the decision-making process by NEMA and obtain approval on behalf of MoE.

A.5 TABLE OF COMPLIANCE WITH THE CONTENT OF THE SEA REPORT

The following table shows the correspondence between the different sections of the report and the content of the SEA report outlined in annex 5 of the National SEA Guidelines.

Requirement	**Addressed in:**
Introduction: Scope and Methodology	Ch. 5: Background and SEA process
Description of the Proposed policy, plan, or program	Ch. 7: Description of proposed Plan
Objective, purpose, and rationale	Ch 5.1: SEA requirements
Alternative policy, options, and strategies	Ch 9.8 Analysis of alternative PPP options
Areas and sectors affected	Ch. 7: Description of proposed Plan
Proposed activities for policy, plan, or program	Ch. 7: Description of proposed Plan
Implementation plan and time scale	Ch. 7: Description of proposed Plan
Environmental analysis	Ch. 9: Biodiversity impact analysis
Description of baseline environmental conditions, especially areas potentially affected	Ch. 9.3: Valued Environmental Components
Relevant legislative framework and related PPP documents	Ch. 8: Governance Framework
Overview of public/stakeholder engagement activities undertaken	Ch. 6: Stakeholder engagement
Prediction and evaluation of impacts, including cumulative effects	Ch. 9: Biodiversity impact analysis
Alternative PPP options considered and compared against environmental indicators	Ch 9.8: Analysis of alternative Plan options
A justification for the preferred alternative	Ch 9.8: Analysis of alternative Plan options
Linkages with ongoing projects and how they fit in the proposed PPP	Ch. 7.3.1 Outlook: large-scale grid connected

	Ch. 7.3.2 Outlook: wind mini-grids Ch. 9.6.9 County-level assessment
Recommendations - Recommended PPP changes; Recommended mitigation measures;	Ch. 10 EMMP
Recommended alternative(s)	Ch 9.8: Analysis of alternative Plan options
The need for subsequent EIA for plans and programmes	Ch 10.6: Conclusions and recommendations
Relevant technical appendices (e.g., stakeholders' meetings minutes)	Ch 12: Appendices
Environmental Management and Monitoring Plan (EMMP)	Ch. 10: EMMP

A.6 QUESTIONS, COMMENTS AND ISSUES RAISED DURING THE WIND POWER AND BIODIVERSITY CONSULTATIVE WORKSHOP HELD ON 12 MARCH 2019 AT NMK

Issue	Response
1. What are the potential impacts of Nuclear energy, which the government is considering developing in Kenya, on wind energy and biodiversity?	This is an interesting subject, but this SEA is not looking into these impacts under the current Terms of Reference, but only in so far as they impact the projected wind power development under the LCPDP
2. What are the impacts of climate change to wind systems in Kenya and role of wind jets?	Wind jets were an interesting submission; if such are consistent, they would be captured in the wind resource maps developed for the country at the appropriate heights for commercial wind power development
3. Why the title was biodiversity, yet the study was biased to birds and bats?	The SEA deliberately focused on volant species as wind power development, particularly turbines, introduce distinct problems for these species
4. The 250W/m^2 class cut-off by IRENA that was adopted in the report might be too low for Kenya. Developers typically target higher wind speeds and as close to the grid as possible	A note was added in the SEA text on this. In the report, we have flagged planned/potential developments already. However, the overall picture in the SEA needs to be broader, e.g., there are also potential trade-offs to make with economic factors Vs biodiversity impacts, thus it was felt better to have a wider rather than narrow view
5. Did you consider offshore wind power development which is gaining traction around the world?	No, this SEA does not consider offshore. This was clarified under the **Scope** sections of the Report
6. Was elevation data considered during classification of species VECs to check whether flight levels coincided with planned hub heights?	Yes, it was explained that this was factored into assessment of intrinsic collision risk under the SEA
7. Did the constraints and challenges you cited related to time and resources available for conducting additional fieldwork and surveys adversely impact the outputs; does this affect the robustness of the results presented based on these data?	While there are still some potential data gaps for VECs species especially E/NE Kenya, the SEA expert consortium believes that the overall findings are robust for a SEA-level analysis and will aid in strategic directions and guiding future ESIAs in this area

Issue	Response
8. It seems like the vulture nest colonies displayed were mainly of cliff-nesting Rüppell's vulture. With some additional effort, we might be able to add nests of other species like the white-backed vultures that form loose nesting colonies	While some known nesting colonies of white-backed vultures were included, we will follow this up by asking TPF/vulture researchers for info on WBV and any other significant vulture nests that can be added onto the map
9. Are you planning on undertaking additional, more detailed studies of the areas mapped as 'hotspots' for wind power and biodiversity?	Not under this SEA. But could be a recommendation especially for any future ESIAs, maybe in more general terms re: need for detailed baseline surveys to assess risk
10. Do you intend to assess the cumulative impacts of wind energy development after regional grid interconnections are completed as this might drive further wind energy development?	The current and planned national and regional grid connections are mapped and considered in the sensitivity analysis; moreover, one would imagine that, to some extent, they will naturally have been considered by wind power developers during siting of their planned or existing wind farms
11. Please provide come county-specific data or analysis to support ongoing efforts at the county level related to renewable energy development, as well as disaster preparedness and management	This idea was taken on-board and a county-level cut of sensitivity analysis – at least summary statistics for the key counties for wind power development – was planned for inclusion in the final SEA report
12. While we would like to publish/share biodiversity findings and data, researchers are often constrained by non-disclosure agreements that they have to sign under most EIA/SEA-related consultancy contracts	This is normally the prerogative of the data owner (wind power developer), but this SEA highlights the importance of data and data sharing, especially for biodiversity-related aspects, and encourages industry players to collaborate in doing so both for efficiency and to save costs
13. To forestall potential issues with the NEMA process in the future, it is important to broaden the stakeholders' coverage as much as possible to ensure all potential actors are reached, particularly wind developers and investors	This was well noted and while the SEA Team made all efforts to reach the broadest constituency of wind power developers, the need for other forms of engagement such as direct/private contact through email or similar means was recognised for certain stakeholders

Issue	Response
14. This SEA is expected to inform decision-making at a high, strategic level in conjunction with other important sectors including social, cultural and land use. Thus, other elements come into play especially transmission lines, which ropes in other key stakeholders like KETRACO, REA and KPLC	This was also well noted, and was recognised that while this SEA made a deliberate choice of focusing entirely and exclusively on biodiversity, the narrowed-down focus meant other key elements of mainstream SEAs were left out. Increasing the scope obviously requires time and additional expertise and resources which made it difficult for the current exercise
15. There are a few other SEAs undertaken countrywide from which this one could learn and glean some information or secondary data (e.g., indigenous peoples) to broaden the analysis and relevance of this SEA even without collection of additional data	Indeed, relevant SEAs have been considered and reference made to these SEAs where appropriate, such as the SESA for the Petroleum Sector in Kenya, and geothermal-related SEAs
16. SEA is about undertaking mitigation analysis and providing options especially spatially around the hotspots revealed on the maps. The SEA should strive to abide by NEMA Guidelines and since SEA is about PPP analysis, I expected this to ask a question like – if the LCPDP was to be implemented as-is, what would be the impacts on biodiversity?	This was noted as true and indeed all proposed projects under the LCPDP have been considered. In order to provide a more complete picture for Kenya, the SEA goes beyond these specific projects and also considers other known (planned or existing) wind power projects in the country. Ultimately, the SEA highlights the proposed developments that are in high sensitivity areas, and recommends fitting mitigation measures
17. There seems to have been some retrogression – after having years of having wooden electricity poles and insulated transmission lines, we are are seeing them now being replaced by the concrete poles with naked lines which are electrocuting even the endangered Rothschild's giraffe	This was noted and a note on this threat added in the VECs section
18. As a strategic document, is this (sensitivity hotspot map) something that the government or industry is obligated to follow?	It was clarified that the SEA provides more general guidelines and recommendations that, once it is ratified would serve to steer future developments especially by guiding project specific ESIAs and ESAPs which are more implementable than a strategic document like a SEA

Issue	Response
19. Perhaps the recommendations should be made distinguished by the risk level (high/moderate/low) associated with each pentad, and specific to the different stages of wind power development in line with the mitigation hierarchy	This was taken on-board, especially the need to specify or align mitigation efforts to potential/actual risks. In the Final Report, we will thus endeavour to give a summary table of responses recommended for high/moderate/low risks/sensitivity
20. Given the importance of transmission lines and additional risks they portend, more effort should be made to reach KPLC, KETRACO and REA to get their buy-in into this exercise	This was taken on-board and indeed, these stakeholders were invited to the scoping and consultative meetings but were not able to attend. This will be followed up as per #13 above
21. The SEA should highlight the most compelling evidence of the implications of potential impacts of wind power development, from both biological and economic angles. This is what attracts attention and gains traction in the policy/political spheres with PS/CS	The SEA aims to provide guidance on the potential impacts of wind development on biodiversity and recommended mitigation measures. Going beyond this into analysing the financial implications for the proposed projects and impact on their viability is beyond the scope of this exercise
22. It is a good idea to broaden the scope of the public engagement process for the SEA, and provide recommendations by county and spatial pentad 'hotness' to expedite mainstreaming into current operational structures and processes	Both taken on board as described under #11 and #13
23. At present, there are about 19 existing projects under the FiT projected to produce about 898 MW when all are completed. The SEA should undertake some economic analysis to shed some like on the potential ramifications of the recommended mitigation measures on these projects, especially the already ongoing ones, particularly in terms of the potential increase in operational costs versus a fixed FiT	While this is a great idea, it is difficult to achieve in time available for completing the SEA besides largely going beyond the scope of this specific SEA. See also #21
24. The SEA should recommend organisation of a multi-stakeholder team to move the key recommendations forward, especially including ERC and KPLC in terms of the potential repercussions of its implementation on projects	This is a good idea and will be added to the recommendations, including the Monitoring Plan

A.7 SCREENING REPORT, KENYA WIND AND BIODIVERSITY SEA

Please see separate file

A.8 SCOPING REPORT, KENYA WIND AND BIODIVERSITY SEA

Please see separate file

A.9 REPORT OF BIODIVERSITY EXPERT WORKSHOP, MARCH 2018

Please see separate file

A.10 INPUT MATERIALS FOR THE BIODIVERSITY EXPERT WORKSHOP HELD IN MARCH 2018

Please see separate file

A.11 REPORT OF CONSULTATIVE STAKEHOLDER WORKSHOP, AUGUST 2018

Please see separate file

A.12 REPORT OF CONSULTATIVE MEETING ON THE SEA FINDINGS, MARCH 2019

Please see separate file

A.13 REPORT ON VULTURE TAGGING, APRIL 2019

Please see separate file

A.14 REPORT OF GAP-FILLING SURVEY FOR RAPTORS AND LARGE BIRDS, OCTOBER 2018

Please see separate file

A.15 REPORT OF GAP-FILLING SURVEY FOR BATS, OCTOBER 2018

Please see separate file