Avian Assessment of the Kleinsee Solar PV Facility, and Grid Connection, Kleinzee, Northern Cape: 2022

Produced for:

Produced by:

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1 SUMMARY

Energy Team (Pty) Ltd have proposed a Solar project near Kleinsee in the Northern Cape. This study is an appraisal of the avifauna likely to occur and the potential risks associated with the proposed 200MW Kleinsee solar PV facility located on the farm Zonnekwa 326 south east of the coastal town of Kleinsee in the Northern Cape. Two site visits in March 2022 (dry) and July 2022 (wet) season, cover the two main biologically active seasons.

Our objective was to determine the presence of collision-prone bird species likely to occur on the proposed photo-voltaic solar energy facility (SEF) in Kleinsee and associated power line infrastructure to assess possible impacts, mitigation, and potential risks to the Priority avifauna. This assessment included the area designated for development (~300-ha) and the immediate surrounding areas to determine the impacts on bird species during 2022.

Possible impacts are:

(i) collision with the PV facility itself from birds perceiving the panels as open water – the "Lake Effect";
(ii) disturbance by construction and maintenance activities;
(iii) displacement through habitat removal and construction work; and
(iv) direct collision or electrocution with the power line network exporting power to the national grid

The location of the solar facility is on the Zonnekwa farm (29°51'15.17"S, 17°16'29.43"E) within an open arid sandy, over-grazed, Succulent Karoo landscape, dotted with small trees and bushes. It is described as *Namaqualand Strandveld*.

Our 1-km transect surveys revealed an average of **12 bird species/km (and a total of 20 species**) within the proposed PV sites while vantage point (VP) surveys recorded three Priority (Collision-prone) species. Bird atlas data and our previous assessment of the Namas grid connection indicates five Red Data species are likely on site: the collision-prone Ludwig's Bustard *Ardeotis ludwigii,* Lanner Falcon *Falco biarmicus,* Secretarybird *Sagittarius serpentarius* and Southern Black Korhaan *Afrotis afra* and possibly Verreaux's Eagle *Aquila verreauxii* with low likelihood. Our surveys at this site only recorded the Southern Black Korhaan.

Passage Rates for the one Priority species seen in flight over 48 hours (two seasons combined) were medium-low at 0.39 birds/hour, and similar for the Red Data species at 0.30 birds/hour. A low species diversity of 46 species of bird was recorded around the SEFs and surrounding areas. No threatened larks (Red Lark *Calendulauda burra,* or Barlow's Lark *C. barlowi*) were recorded on site either. The DFFE Screening Report classifies the area as of High Sensitivity for the Animal Theme and Low sensitivity for the avian theme with respect to renewable energy. BBU concurs with both statements.

The construction of a 132kV new power line of 8.2-km may create a risk for the highly collision-prone Ludwig's Bustards recorded on site. Given the medium risk impact we strongly recommend that the new line is aligned as closely as possible with the newly constructed 400 kV Gromis-Juno line to increase line visibility to minimise fatalities.

Upon present evidence, this PV site supports a low diversity of Priority species, and thus the loss of a small footprint of relatively over-grazed area will have a minimal effect on the depauperate avian community here.

Thus, no mitigations are required for the Solar facility itself, but close alignment (and staggered pylons) are recommended for the 132 kV power line connection. Birds & Bats Unlimited see no reason why the solar farm and associated grid connection here should not get environmental approval from an avian perspective.

2 QUALIFICATIONS OF SPECIALIST

2.1 Consultant's Declaration of Independence

Birds & Bats Unlimited are independent consultants to Energy Team (Pty) Limited. They have no business, financial, personal, or other interest in the activity, application, or appeal in respect of which they were appointed other than fair remuneration for work performed in connection with the activity, application, or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work.

I, Dr Robert E. Simmons, as the appointed independent specialist, in terms of the 2014 EIA Regulations, declare that:

- I act as the independent specialist in this application;
- I perform the work in an objective manner, even if this results in findings that are not favourable to the applicant;
- I regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have, and will not have, any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Dr RE Simmons
Date: 6 October 2022
Revised: 1 December 2022, and 27 March 2023

This report was co-authored with Marlei Martins (co-Director of Birds & Bats Unlimited) and Jessleena Suri. They too adhere to the principles listed above and MM's profile can be found at www.birds-and-bats-unlimited.com/birds

2.2 Qualifications of Specialist Consultant

Birds & Bats Unlimited (www.birds-and-bats-unlimited.com/) were approached to undertake a specialist avifaunal assessment for the pre-construction phase of the proposed Kleinsee Solar PV, southeast of Kleinsee. Dr Robert E Simmons is an ornithologist with 35 years' experience in avian research and impact assessment work in Africa, North America, Europe, and Asia. He has published over 110 peer-reviewed papers and two books, (see www.fitzpatrick.uct.ac.za/fitz/staff/research/simmons for details). A total of 65 projects and assessments over 23 habitats have been undertaken in Angola, Namibia, Kenya, Lesotho, and South Africa. With his students at the FitzPatrick Institute, UCT, where he is an Honorary Research Associate, he also undertakes long-term research on threatened species (raptors, vultures, flamingos, and terns) and the impacts of predatory domestic cats on biodiversity.

Marlei Martins, co-director of Birds & Bats Unlimited, has 10 years' consultancy experience in over 60 avian wind and solar farm impact assessments as well as 20 years in environmental issues and rehabilitation. She has been employed by several consultancy companies throughout South Africa because of her expertise in this field. She has published papers on her observations, including a population viability assessment of one of South Africa's most *Endangered* raptors https://royalsocietypublishing.org/doi/10.1098/rsos.220043

3 BACKGROUND

3.1 Photo-voltaic Solar Power

Under the government's Integrated Resource Plan, South Africa is promoting the implementation of renewable energy and phasing out further nuclear energy. The Minister of Energy stated in October 2019 that additional energy capacity will be provided by Photo-voltaic (PV: 6 814 MW), solar (8 100 MW) and gas (8 100 MW) to 2030. At that time the energy mix will be coal 34 000 MW (or 46% of total installed capacity), nuclear 1 860 MW (or 2.5%), PV 9129 MW (10%), solar 19 104 MW (15%), and concentrated solar power 600 MW (1%). Thus, solar farming will provide ~15% of South Africa's energy mix and eight zones have been identified in South Africa where renewable energy will be concentrated (REDZ).

To meet these needs Energy Team (Pty) Ltd have proposed a solar energy facility for the Succulent Karoo region south of Kleinsee in the Northern Cape. Several sites around here have been assessed for birds and found to support generally low avian species richness.

The development of a solar photovoltaic (PV) facility with a contracted capacity of up to 200MW is proposed by Energy Team (Pty) Ltd on a site approximately 20-km west of Komaggas, and 30-km southeast of Kleinzee, in the Namakwa District Municipality, Northern Cape. The development will be known as the Kleinsee Solar PV Facility and is located in Renewable Energy Development Zone (REDZ 8), in the Northern Corridor of the Strategic Transmission Corridors.

The infrastructure associated with the 200MW solar PV facility will include:

- Solar PV array comprising PV panels and mounting structures
- Inverters and transformers
- Low voltage cabling between the PV modules to the inverters
- 33kV cabling between the project components and the facility substation
- 132kV onsite facility substation
- 132kV power line to connect to the grid at the Zonnequa Collector Substation within a 300-m wide and approximately 8.5-km long corridor
- Battery Energy Storage System (BESS)
- Site offices and maintenance buildings, including workshop areas for maintenance and storage
- Laydown areas and site access and internal roads.

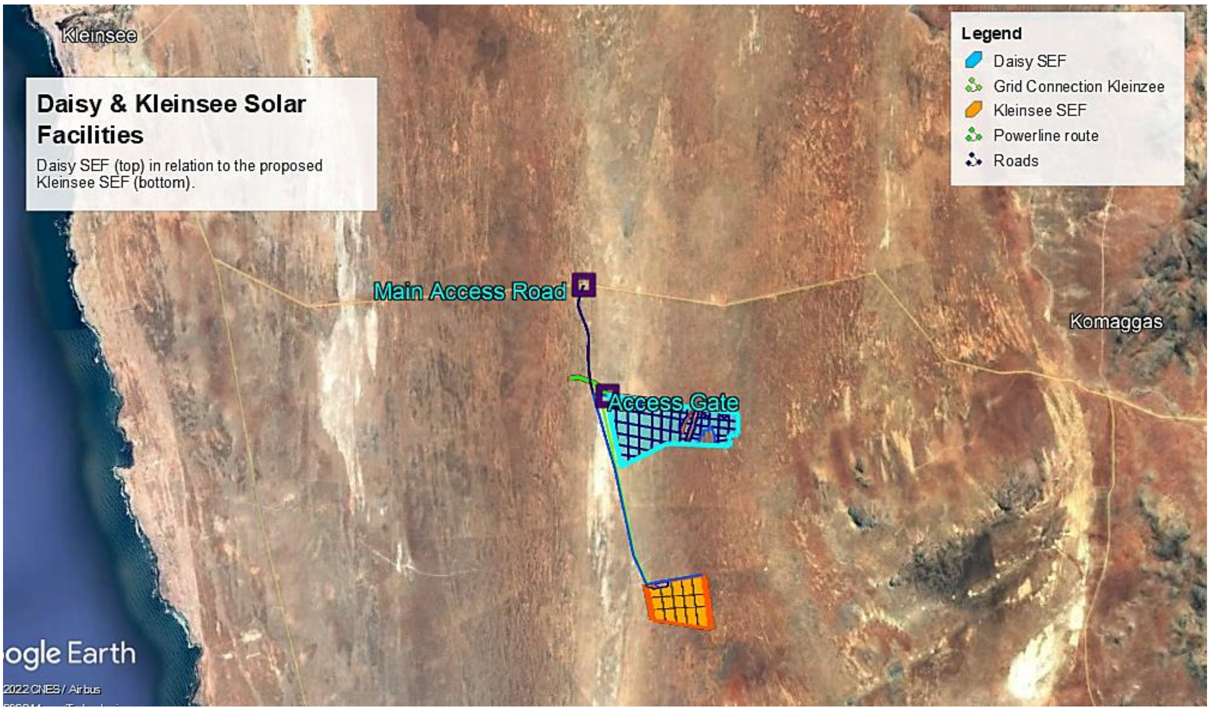


Figure 1: The KLEINSEE Solar PV site (orange polygon) in relation to the Daisy Solar site (blue polygon) and the closest towns, Kleinsee in the Northwest, and Komaggas in the east.

The power generated by the Kleinsee Solar PV Facility will be sold to Eskom to feed into the national electricity grid. Ultimately, the Kleinsee Solar PV facility and the associated grid connection infrastructure is intended to be part of the renewable energy projects portfolio for South Africa, as contemplated in the Integrated Resources Plan (IRP) and Renewable Energy Independent Power Producer Procurement (REIPPP) Programme.

The **Kleinsee Solar PV development** comprises an area of ~300-ha of which some will be developed for the solar farm itself. Past faunal assessments (Birds & Bats Unlimited 2017) have previously identified sensitive areas in the Namas and Zonnequa areas close to the site under observation.

3.2 Potential Avian Impacts

As with any development, habitat will be permanently disturbed, displacing the resident and migrant species. The majority of the 300-ha area is planned in the operation of the PV facility, and this will reduce habitat availability for birds where construction takes place.

The main avian impacts according to a position paper on the subject by Birdlife SA are:
http://www.birdlife.org.za/images/stories/conservation/birds_and_wind_energy/solar_power.pdf

(i) displacement of nationally important species from their habitats;
(ii) loss of habitats for such species;
(iii) disturbance during construction, and operation of the facility;
(iv) collision with the photovoltaic panels (mistaking them for water bodies);
(iv) collision with the 132 kV power line.

3.2.1 Habitat Loss – Destruction, Disturbance, and Displacement

The construction and maintenance of PV technology causes mainly permanent habitat destruction and disturbance. Maintenance activities are likely to cause some disturbance to birds in the general surrounds, especially the shy or ground-nesting species resident in the area. Mitigation of such effects requires that best-practice principles be applied – i.e., sites are selected to avoid the destruction of key habitats for Red Data species, and the disturbance and construction and the final footprint size, for key species, should all be kept to a minimum.

4 METHODS

As a first step, the overall avian sensitivity of the Kleinsee site can be gauged from Birdlife South Africa's sensitivity map at www.birdlife.org.za/conservation/terrestrial-bird-conservation/birds-and-renewable-energy/solar-farm-map. This is an estimate of the sensitivity to birds of wind farms (not solar farms), covering all pentads (that is a 5-minute x 5-minute polygon of about 7-km x 8-km) based on Red Data birds and, particularly, those that are collision-prone with respect to wind farms. We have used the wind farm species as surrogates for those for solar farms as a guide only. The sensitivity scale varies from low (~100) to very high (~1000) and is designed to guide development away from the highest sensitive areas but is not intended to replace the need for an EIA or to designate "No-go areas".

The second step is to use the DFFE Screening Tool to investigate the Animal and Avian themes. This was accessed from https://screening.environment.gov.za/screeningtool/#/app/screen_tool/Solar%20PV

The threat status of all species is important to determine given that Red Data species are more susceptible to change and population limitation than more abundant, *Least Concern* species. This was gauged from Taylor et al. (2015) while the biology and ecology of all species was drawn from Hockey et al. (2005).

Two site visits were undertaken in the dry (March) and wet (July) seasons to determine species richness, abundance, and flight frequency over the solar site. Four days were spent on site in March and four days in July 2022.

Vantage Point (VP) observations were undertaken for 6 hours per day from VPs in the east and west sections of the site and all flights of the Priority collision-prone species (Ralston Paton et al. 2017) were recorded on laminated Google Earth images in the field. From the number of flights, we calculated the Passage Rates (bird flights per hour) through and near the PV site as a measure of the risk to each species. Vantage Point observations of 12 hours are recommended by the Birdlife South Africa guidelines for this species (Ralston Paton 2017).

In addition to VP observations for larger species we undertook two 1000-m transects for the smaller species, inside the proposed solar footprint and immediately outside the boundaries.

To define risk areas for the Priority birds we combine two measures of avian activity in the following way:

- Reporting rate as a measure of how often the species is likely to occur on site.
- Passage Rate as a measure of how often the species traverses the airspace in the site.

Medium Risk areas are defined where two or more Priority species occur on site and have a reporting rate >10%, a Passage Rate > 1 flight per day (0.1 flights/hour).

Medium-High areas are defined where one Red Data species or two or more Priority species overlap on site and have a reporting rate >10%, a Passage Rate > 1 flight per day (0.1 flights/hour).

High-Risk areas are defined where two or more Red Data species overlap on site and have a reporting rate >10%, a Passage Rate > 1 flight per day (0.1 flights/hour).

Three observers were used:

- Marlei Martins, avian specialist, and conservationist with 12 years' experience with EIAs in South Africa.
- Eric Herrmann, bird guide, and long-term birder with decades of experience in the Northern Cape.
- Rob Simmons, avian specialist, and ecologist with 35 years' experience in avian research.

4.1 Data limitations

High-resolution bird data are typically available through the SABAP2 bird atlas scheme of the Animal Demography Unit at University of Cape Town available at http://sabap2.adu.org.za/map_interactive.php. Despite the total 76 cards fewer were submitted for the inland areas covering this development.

Solar farm fatality data are rarely recorded in South Africa and avian collision proneness is mainly based on short-term records from Visser et al. (2017) at a large PV site and Jeal (2018) from a trough technology solar site. All South African bird species have been tabulated and ranked by Ralston-Paton et al. (2017) for wind farms and only the top 100 species (of 900) are categorised here as Priority collision-prone. These rankings may change as more quantitative data are analysed from solar farms.

Short site visits at the pre-construction stage can only ever give a snapshot of what species may occur, as rain events are the main driver of bird abundance and bird diversity in arid areas (Dean 2004, Seymour et al. 2015). Fortunately, rain fell between our March and July visits and brought some nomadic species such as bustards and larks into the area.

4.2 Study methods

4.2.1 Aims and Terms of Reference

The primary aims of the avian pre-construction monitoring at the PV sites proposed are to:

1. Determine the densities of birds regularly present, or resident, within the impact area of the PV before the construction phase;
2. Document the patterns and movements of birds in the vicinity of the proposed PV before its construction;
3. Monitor the patterns and movements of birds in the PV area in relation to time of day, and over a dry and wet season when bird numbers and species richness may change;
4. Establish a pre-impact baseline for all Red Data and endemic bird species including all breeding birds on site;
5. Quantify the impacts before and after mitigation; and
6. Inform final design, construction, and management strategy of development to mitigate potential impacts.

The level of survey intensity as recommended by the Birdlife South Africa solar guidelines (Jenkins et al. 2015) is based on:

(i) the avian sensitivity of the area according to SABAP 2 and the BLSA sensitivity map; and
(ii) the size of the area.

According to these criteria the avian sensitivity is ranked as **Medium** by the Birdlife avian sensitivity map (Figure 2), of **High** Sensitivity in the Animal species theme, but **Low** by the avian theme in the DFFE Screening Tool (Appendix 1).

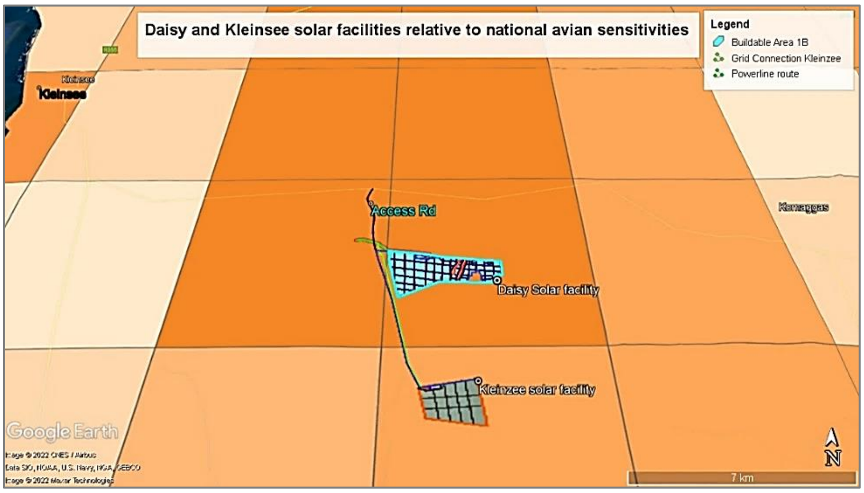


Figure 2: Avian sensitivity of the area on which the two proposed solar farms (Daisy, top, and Kleinsee, bottom) are proposed. The sensitivity is ranked as 605 (out of ~1000) and thus *medium* from this Birdlife avian sensitivity perspective.

Thus, the area can be considered of *Medium* sensitivity overall and, due to its small size, the site requires 2-3 site visits. During the two site visits (dry season of March 2022 and wet season of July 2022), two observers surveyed the proposed Kleinsee PV site over two 2-day periods. The 4-days thus comprised a total of 24 hours.

Our surveys comprised:

(i) 2 x 1.0-km Walking transect survey,

(ii) 12 hours of observations for each of the two Vantage Point (VP) for a total of 24h per season for two seasons (wet and dry);

(iii) Each of the two VPs covered a 1.5-km radius viewshed and encompassed the entire study site

Vantage point (VP) observations were undertaken for 12 hours, spread evenly over two days and across the daylight period from fixed points. Two VPs were required due to the small size of the proposed SEF (Figure 2, red circles).

From the resulting VP survey, we recorded the flight paths of all large collision-prone species, as well as aerial species such as sandgrouse, swifts, and swallows.

5 STUDY AREA

The ~300-ha solar site to be developed by Energy Team (Pty) Limited is located on the remaining extent of farm Zonnekwa 328. The farm is centred on S 29.800620° E17.284067°.

5.1 Vegetation of the Study Area

The study area occurs at the north-west end of the Nama Karoo biome (Mucina and Rutherford 2006, p264) and is designated as Namaqualand Strandveld. It is dominated by low species-rich shrubland of erect and creeping succulents on nutrient-poor sand and heavily grazed in places. The sheep are moved off the land in the summer when temperatures increase, and rainfall decreases.

The study area experiences winter rainfall averaging a low 112-mm per annum, with high variability. Most falls in June-July-August (winter). In our 12-month visit little rain had fallen and by the summer and autumn visits the veld was dry and mainly moribund. From our experience in the area, at times of more average rainfall we are able to extrapolate which species may occur and their likely abundance when typical rainfall occurs.

Maximum day time temperatures average about 10-20°C from winter to summer. Minimum temperatures average ~7-15°C. Minimum night-time temperatures rarely dip below zero for the winter months (Mucina & Rutherford 2006).

5.2 Avian Microhabitats

Bird habitat in the region consists of uniform vegetation type of coastal shrubs and succulent plants. The vegetation includes succulent shrubs such as *Tertragonia, Cephalophyllum* and *Didelta* and non-succulents such as *Eriocephalus, Pteronia* and *Salvia*. There are a few alien trees on site (Eucalyptus), found around the farmsteads, and some farm dams and water points for sheep. Few grasses are found, making the lark species diversity rather slim within the site. One Eskom reticulation line with monopoles is found within the site, providing some perch sites for raptors but no nesting sites.

6 RESULTS

6.1 Presence and movements of sensitive species

Large Priority species are defined as those species that are known, or expected, to be at risk from the PV infrastructure, or attracted by the reflective surfaces of the PV panels. Some data were available from bird atlas cards of Southern African Bird Atlas Projects (SABAP), website (http://sabap2.adu.org.za/index.php), many of which were logged by BBU in our previous site visits.

6.2 Avian species richness and Red Data species

A total of only 46 bird species were recorded around the Kleinsee PV site from our four days of surveys on Kleinsee and an additional eight days on surrounding solar farms. Three of these were collision-prone species: one Red Data species Southern Black Korhaan *Afrotis afra* and two *Least Concern* Greater Kestrel and Pale Chanting Goshawk.

From the larger data from SABAP2 a total of 12 Priority species have been recorded from the same area (Table 1) of which six are Red Data species (two bustards, three raptors and one korhaan). A total of 92 species have been recorded on the same cards.

Table 1. All (12) Priority collision-prone bird species including those Red-listed (**in red**) likely to occur over the proposed Kleinsee Solar site drawn from 33 cards by SABAP2 in the 12 pentads that surround the Kleinsee SEF site. Those species grey-shaded were recorded on the proposed Kleinsee site in March and July 2022.

				Susceptibility to:	
Common Name	**Scientific Name**	**Red-list status**	**Reporting Rate ***	**Collision (Rank **)**	**Disturbance**
Verreaux's Eagle	*Aquila verreauxii*	**Vulnerable**	**17%**	**2**	**Medium**
Ludwig's Bustard	*Neotis ludwigii*	**Endangered**	**26%**	**10**	**Medium**
Kori Bustard	*Adeotis kori*	**Near Threatened**	**24%**	**37**	**Medium**
Secretarybird	*Sagittarius serpentarius*	**Vulnerable**	**13%**	**12**	**High**
Lanner Falcon	*Falco biarmicus*	**Vulnerable**	**20%**	**22**	**Medium**
Southern Black Korhaan	*Afrotis afra*	**Vulnerable**	**38%**	**35**	**Low**
Jackal Buzzard	*Buteo rufofuscus*	Least Concern	15%	42	Low
Booted Eagle	*Aquila pennatus*	Least Concern	38%	55	Medium
Black-chested Snake Eagle	*Circaetus cinerescens*	Least Concern	28%	56	Medium
Pale Chanting Goshawk	*Melierax canorus*	Least Concern	70%	73	Low
Greater Kestrel	*Falco rupicolloides*	Least Concern	70%	97	low
Spotted Eagle Owl	*Bubo africanus*	Least Concern	14%	100	low

[a]Reporting rate is a measure of the likelihood of occurrence, as recorded in the atlas period (detections/number of cards)
[b] Collision rank derived from the BAWESG 2014 guidelines. Smaller numbers denote more collision prone.

In summary, three **collision-prone Priority species** were recorded on site, of which **one was red-listed.** Other species are likely as suggested by the SABAP2 atlas record of 12 Priority species (of which six are Red Data) (Appendix 3).

6.2.1 Density of birds in the Kleinsee PV site

From the 1.0-km transects performed within the PV site we recorded 11 species/kilometre in March 2022 and 12 species after the rains in July, for a total of 20 species (Table 2). In comparison, walking transects performed outside the proposed solar arrays (Control) recorded 12.0 species/km in March 2022. The total number of species recorded in all transects and vantage point surveys was 46 species (Appendix 2).

Table 2: Overall bird densities from 1.0-km transects of the Kleinsee PV site in March and July 2022.

Bird densities from 1-km transects	**Species/km**	**Birds/km**	**Species/km**	**Birds/km**
	March (dry)	March (dry)	July (wet)	July (wet)
Densities for the Kleinsee PV site	11	20	12	23
Outside PV sites (Control)	12	32	No data	No data

6.2.2 Passage Rates of Priority birds in the Kleinsee site

Passage Rates are a measure of the number of collision-prone Priority birds flying (passing) through a given Vantage Point area per hour. This is an important metric given that Passage Rates of Collision-prone species are significantly related to fatalities at wind farms (Simmons and Martins 2019).

Nine flights of three Priority species in 23 hours gives a medium-low Passage Rate of 0.39 flights per hour for the Priority birds over the proposed Kleinsee PV site (Table 3). Most of these flights were recorded in the wet season (July) 2022

Table 3: Records of the three Priority species recorded during Vantage Point observations in March and July 2022 at the proposed Kleinsee PV solar site.

KLEINSEE Solar Farm: Mar 2022

Date	**Obs period**	**VP**	**Hrs**	**Time**	**No**	**Species**	**Age**	**Sex**	**Height**	**Seconds**
2022/03/03	10h30-16h30	KZ1	6	-	-	No birds				
2022/03/06	7h30-12h30	KZ1	5	7:50	1	**Greater Kestrel**	Ad	U	5,5m	20
					1	**Pale Chanting Goshawk**	Ad	U	10;10;15;15;15;30;40;50;60	120
			11		**2**	**Birds 2 Species**	**GK,PCG**			
KLEINSEE	**Passage Rates**				**=**	**0.18**	**Birds / h**			
				Red Data		**0.00**	**Species/ h**			

KLEINSEE Solar Farm: Jul 2022

Date	**Obs period**	**VP**	**Hrs**	**Time**	**No**	**Species**	**Age**	**Sex**	**Height**	**Seconds**
2022/07/03	9h00-15h00	KZ1	6	10:51	2	**Southern Black Korhaan**	Ad	M	5;5;5	30
				11:26	2	**Southern Black Korhaan**	Ad	M	5;5	20
				11:31	1	**Southern Black Korhaan**	Ad	M	5;5	15
				11:43	2	**Southern Black Korhaan**	Ad	M	5;5	15
2022/07/05	1:40-14:40	KZ1	6		-	No birds				
			12		**7**	**Birds 1 Species**	**SBK**			
KLEINSEE	**Passage Rates**				**=**	**0.58**	**Birds / hr**			
						0.58	**Red Data sp/hr**			

KLEINSEE SEF	**COMBINED**	**Hr**	**Species**		
Mar & Jul		**23**	**9**	**0.39**	**Birds / hr**
2022		**23**	**7**	**0.30**	**Red Data sp/hr**

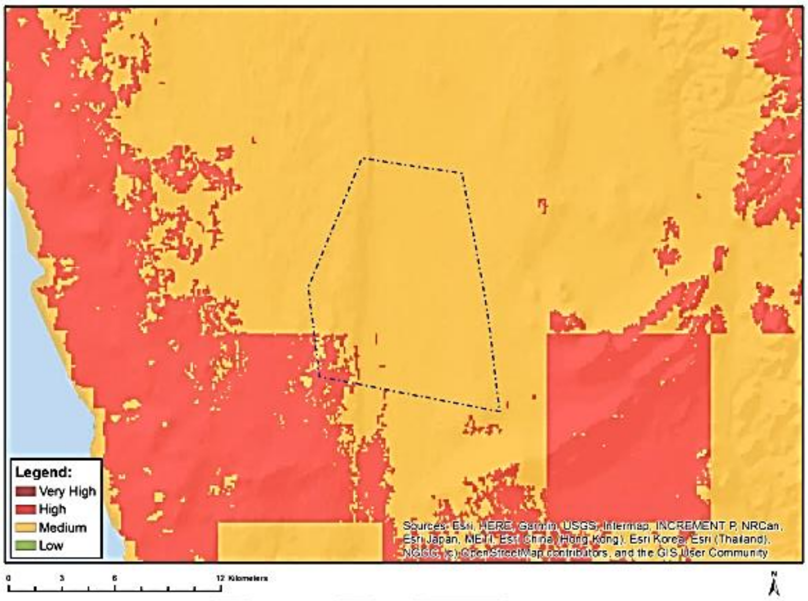
The Passage Rate of threatened Red Data species was medium-low at 0.30 flights per hour over the course of March and July 2022. The only Red Data species recorded on site was the Southern Black Korhaan, thus the proposed site can be seen as of relatively low significance for Red Data species, even following rains in July 2022.

The overall Passage Rate for all Priority species was also Medium-low at 0.38 birds/hour.

6.3 Screening Tool assessment in comparison with local findings

The DFFE Screening Tool outcome for the site (Figure 3) ranks the area as of High Sensitivity for the Animal Theme, based on the presence of Lanner Falcons and Southern Black Korhaans. Our own surveys reveal similar species at relatively low density, but also including Ludwig's Bustard. We therefore support this classification. The Avian Theme for the area (Appendix 1) indicates a Low sensitivity for solar farms, with which we also agree.

MAP OF RELATIVE ANIMAL SPECIES THEME SENSITIVITY



Where only a sensitive plant unique number or sensitive animal unique number is provided in the screening report and an assessment is required, the environmental assessment practitioner (EAP) or specialist is required to email SANBI at eiadatarequests@sanbi.org.za listing all sensitive species with their unique identifiers for which information is required. The name has been withheld as the species may be prone to illegal harvesting and must be protected. SANBI will release the actual species name after the details of the EAP or specialist have been documented.

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Aves-Falco biarmicus
High	Aves-Afrotis afra
Medium	Aves-Afrotis afra
Medium	Aves-Circus maurus
Medium	Insecta-Chrysoritis trimeni
Medium	Sensitive species 32
Medium	Invertebrate-Brinckiella mauerbergerorum

Figure 3: The outcome of the DFFE Screening Tool assessment for the Animal theme for the Kleinzee SEF. The areas is ranked as of High Sensitivity.

Figure 4: Priority bird flights over the proposed Kleinsee solar farm (= pale blue polygon). One Red Data species was recorded (Southern Black Korhaan = mauve line), and two other species (Pale Chanting Goshawk and Greater Kestrel) also occurred. The red circles are our 1.4-km viewshed. The Passage Rate for the site was medium-low at 0.38 flights/hour, and similarly low for the Red Data species (0.30 birds/hr). Because of the low number of threatened species occurring over the proposed SEF, no high-risk areas are designated in this proposed solar farm.

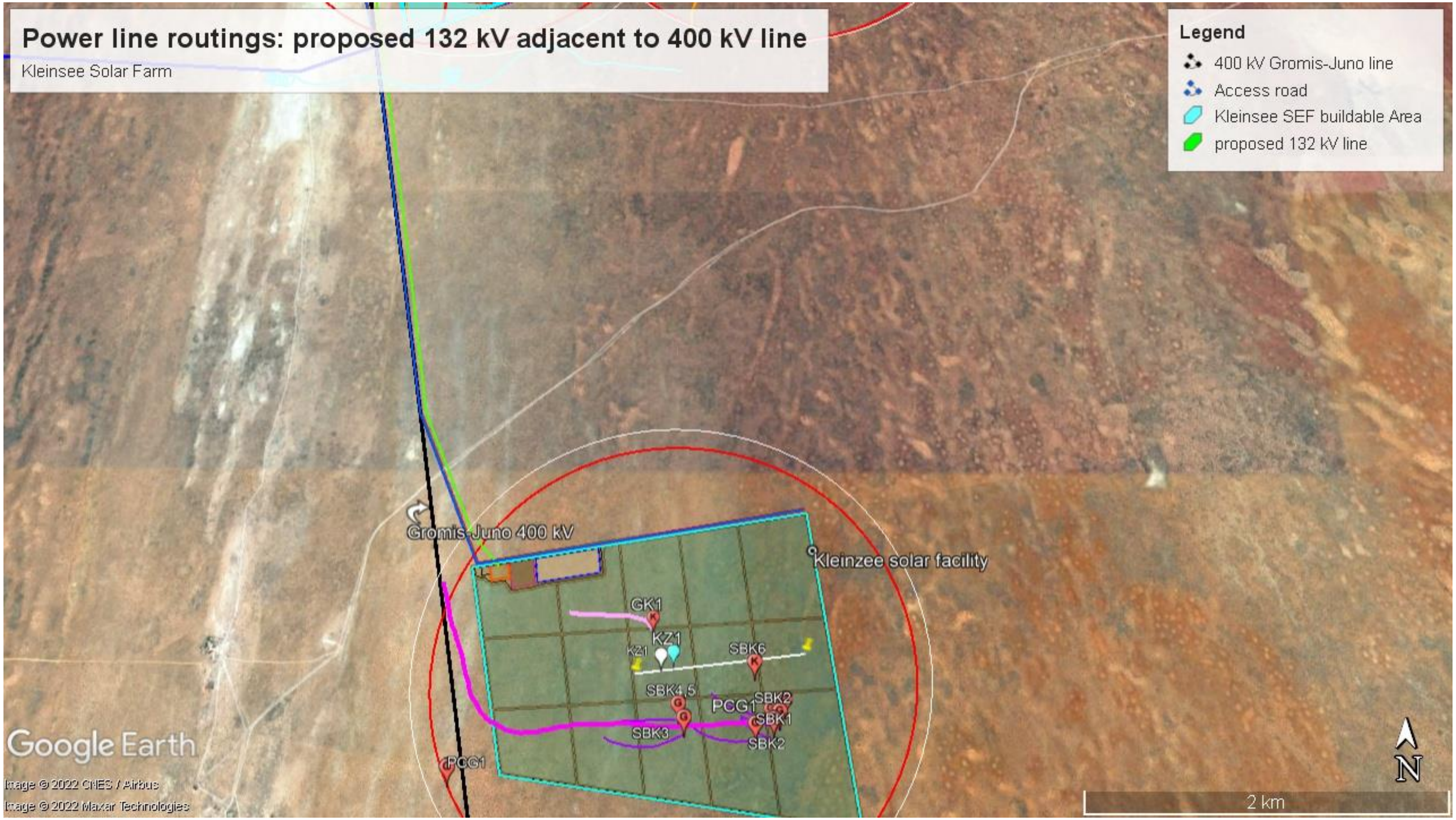


Figure 5: Power line routings from the Kleinsee solar farm in relation to bird flights recorded in and around the solar site (= light blue polygon). The proposed 132 kV line (= green line) exporting the energy to the national grid via the 400 kV Gromis-Juno line (= black line) is routed alongside the extant 400 kV line. This allows the new mitigation of staggered pylons to be enacted to reduce impacts by all collision-prone species.

7 QUANTIFYING THE IMPACTS

Here we semi-quantify the solar farm and grid connection impacts and evaluate the advantages of various forms of mitigation to reduce expected impacts. The SEF is assessed first followed by the 8.2-km 132 kV power line.

Nature: The impact of the proposed SEF area will generally be negative for birds given the certainty that: (i) ~300-ha of habitat will be transformed and potentially fragmented; (ii) birds may be killed directly if they fly into the proposed 132 kV power line. Some displacement may also occur.

The Extent (**E**, from 1-5) of the impact will be local within the 300-ha area = **(1)**.

The Duration (**D**, from 1-5) will be long-term **(4)** for the lifetime of the SEF. This is so for all collision-prone species.

The Magnitude (**M**, from 0-10) of the SEF area is expected to cause a low impact **(3)** for the raptors and other Red Data species.

The Probability of occurrence (**P**, from 1-5) of the Priority species (Southern Black Korhaan, Pale chanting goshawks, Greater Kestrel) having some sort of interaction with the SEF site is ranked as medium **(3)** because of their presence (~20% to 70% likelihood of occurrence) but medium-low passage rates (0.38 birds/h or 0.30 Red Data species/h) on the proposed wind farm.

The Significance S, [calculated as S = (E+D+M)P], is as follows (Table 4) for the species identified as at risk in the (i) wind farm site.

The scale varies from:

- 0 (no significance), to≤30 Low (this impact would not have a direct influence on the decision to develop in the area), to
- 30-60 (the impact could influence the decision to develop in the area unless it is effectively mitigated),
- >60 (the impact must have an influence on the decision process to develop in the area).

Table 4. A quantification of impacts to the three, main, collision-prone species likely to be impacted by the proposed Kleinsee SEF.

SEF development site

Nature: Negative due to disturbance and loss of foraging habitat around the SEF site for the Red-listed bird groups identified at risk above.

- The raptors (Martial, Snake-eagle and Chanting Goshawk) are the raptors species most likely to be impacted. The Pelicans recorded off site are at less at risk.

	Without mitigation	**With mitigation**
Extent	**1**	**1**
Duration	**4**	**4**
Magnitude	**3**	**3**
Probability	**3**	**3**
Significance (E+D+M)P	**24 (low)**	**24 (low)**
Status (+ve or –ve)	Negative	Negative
Reversibility	No, habitat will be permanently altered	
Irreplaceable loss of species?	No	
Can impacts be mitigated?	No	

Mitigation for SEF site:

The mitigation for birds around solar facilities are as follows:

- position panels away from sensitive habitats (there were none identified at the Kleinsee site)

Residual impacts:

Direct mortality through collision, or area avoidance, may occur if wetland birds are attracted by the shiny solar panels This possibility can be gauged from a systematic monitoring programme.

Table 5. A quantification of impacts to the main, collision-prone species likely to be impacted by the 132 kV power line at the Kleinsee SEF.

<table>
<tr><td colspan="3"><u>132 kV Power line development</u>
Nature: Negative due to potential for collision and electrocution for the Red-listed Bustards (collisions) and raptors (electrocution)
➢ Ludwig's Bustards that occur in the surrounding areas are most at risk, while the raptors (Greater Kestrel, Chanting Goshawk) are the species most likely to be electrocuted if conductors are exposed above the support structures.</td></tr>
<tr><th></th><th>Without mitigation</th><th>With mitigation</th></tr>
<tr><td>Extent</td><td>1</td><td>1</td></tr>
<tr><td>Duration</td><td>4</td><td>4</td></tr>
<tr><td>Magnitude</td><td>8</td><td>7</td></tr>
<tr><td>Probability</td><td>4</td><td>3</td></tr>
<tr><td>Significance (E+D+M)P</td><td>52 (medium-high)</td><td>36 (medium)</td></tr>
<tr><td>Status (+ve or –ve)</td><td>Negative</td><td>Negative</td></tr>
<tr><td>Reversibility</td><td>Yes, with appropriate contemporary mitigations</td><td></td></tr>
<tr><td>Irreplaceable loss of species?</td><td>No</td><td></td></tr>
<tr><td>Can impacts be mitigated?</td><td>Yes</td><td></td></tr>
<tr><td colspan="3">Mitigation for 132 kV power line:
The top mitigation for birds around new power lines are as follows:
• Stagger the pylons such that the new line parallels the existing line and the pylons of one align with the midspan of the existing line. This is expected to reduce fatalities of all species by 67% (Pallett et al. 2022)
• Affix bird diverters (spirals) to the earth wire as the line goes up. This is known to reduce fatalities of large birds by 60% and 90% (Shaw et al. 2021)
• All configuration for the conductors must be bird-friendly and be slung below the support structures to avoid any danger of electrocution (See Appendix 3 for safe and unsafe designs)</td></tr>
<tr><td colspan="3">Residual impacts:
Direct mortality through collision, or area avoidance, may occur if wetland birds are attracted by the shiny solar panels This possibility can be gauged from a systematic monitoring programme.</td></tr>
</table>

7.1 Cumulative Impacts

7.1.1 Other Solar and wind facilities

Cumulative impacts are defined as "impacts that result from incremental changes caused by either past, present or reasonably foreseeable actions together with the project" (Hyder, 1999, in Masden et al. 2010).

In this context, cumulative impacts are

- those that will impact the general avian communities in and around the Kleinsee Solar Farm development, mainly by other wind and solar farms and
- associated infrastructure in the form of power lines in Succulent Karoo surrounds.

We here focus on fatalities through collisions, associated with renewable energy developments, as they are easier to quantify than displacement effects. As a starting point, the number of renewable energy developments within a 50-km radius of the site need to be determined and secondly and their impact on avifauna estimated.

Given the general assumption that footprint size and bird impacts are linearly related for wind farms, a starting point in determining cumulative impacts is to determine:

- the number of birds displaced per unit area, by habitat destruction, or disturbed or displaced by human activity;
- the number of birds killed by collision with the solar facility on site; and
- the number of birds killed by collision with infrastructure (e.g., power lines) within, or leading away from, the site.

Seven renewable energy developments are currently on record with the Department of Environmental Affairs within 50-km of Kleinsee SEF (Table 6), of which one has lapsed. The combined energy output of the six "approved" projects is 841.2 MW of which wind energy comprises 681.2 MW and solar 160 MW (Table 6).

Table 6: All renewable energy projects within a 50-km radius of the Kleinsee SEF, and their approval status with the DEA. Source: DFFE webpage https://egis.environment.gov.za/data_egis/data_download/current_2022, second quarter.

	Project Title	Distance from Kleinsee	Technology	Megawatts	Current Status
1	Kap Vley WEF	0 km	Wind	300 MW	Approved
2	Kleinsee WEF	4.5 km	Wind	300 MW	Approved
3	Daisy SEF (previously the Namas WEF)	5.0 km	Solar	200 MW	In process
4	Project Blue Kleinsee WEF	22.0 km	Wind	74 MW	Approved
5	Nigramoep PV Solar Energy Facility on a site near Nababeep	40 km	Solar	20 MW	In process
6	Koingnaas WEF	35 km	Wind	7.2	Approved
7	Karen Energy Groen Bank	50 km	Solar	0	Lapsed
Summary: 6 renewable energy facilities (4 WEFs, 2 SEF) Total power output: WIND 681.2 MW **SOLAR 200 MW** (901.2 MW)					

We populated the Cumulative Impacts table with avian fatality rates from published and unpublished studies and theses. We sourced data from:

(i) post-construction wind farm data from avian assessments summarised by Birdlife South Africa from 1-2 years' post-construction monitoring (Perold et al. 2020) (Table 7); and

(ii) Visser et al. (2019) for the only solar-avian fatality assessment from South Africa

The national review of post-construction data (Table 8), including data from Northern Cape wind farms, indicates that:

- South African wind farms kill about **4.6 ± 2.9** birds per turbine per year (corrected for bias), similar to the international mean of bias-corrected estimates of 5.25 birds per turbine per year (see Review [Point 5] above).
- The equivalent number of fatalities per Megawatt is **2.0 ± 1.3 birds per MW** per year (Perold et al. 2020). Of concern is that 36% of the South African fatalities recorded are raptors (Table 7).
- Using these values, we can calculate the number of birds likely to be killed per megawatt.
- For solar PV sites the equivalent fatality estimates (based on one farm) was **4.5 ± 3.5 birds per MW per year** (Visser et al. 2019). This is likely an over-estimate, but we have no other estimates with which to correct it.

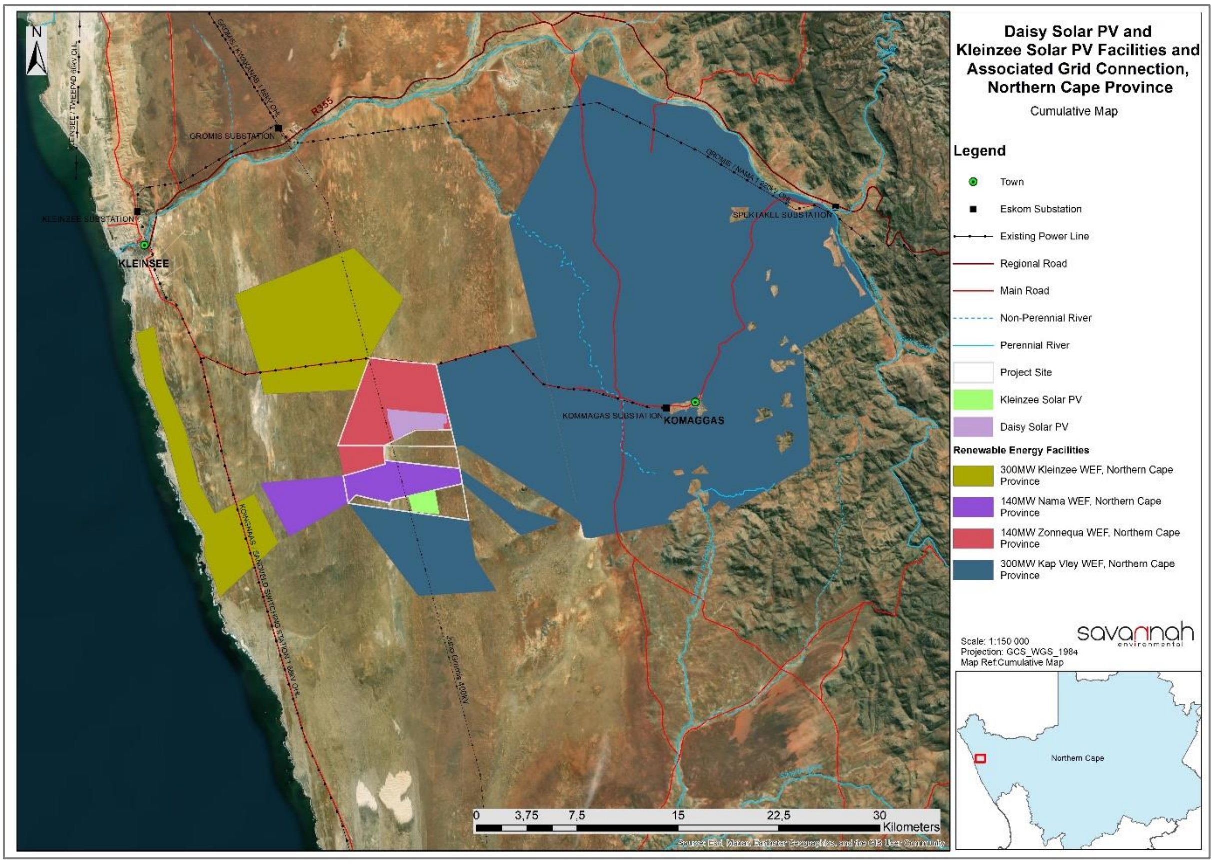


Figure 6: All 7 proposed renewable energy (RE) developments within a 50-km radius of the proposed Kleinsee solar farm. Four sites are wind farms and two are solar farms.

We can estimate the potential cumulative number of fatalities using the known fatalities from Perold et al. (2020). The total power output of all proposed wind farms within 50-km is 901.2 MW.

The potential fatalities attributable to each form of renewable energy is given in Table 8.

Table 7: Avian fatalities arising from the cumulative total of all authorised wind and solar projects within 50-km of the proposed Kleinsee solar farm

Calculating avian fatalities due to WIND + SOLAR PV farms for CUMULATIVE IMPACTS		
WIND	**Number of wind MWs near Kleinsee SEF**	**Total fatalities**
2.0 ± 1.3 birds/MW/year	681.2 MW	1362 birds killed
SOLAR	**Number of solar MWs near Kleinsee SEF**	**Total fatalities**
4.5 ± 3.5 birds/MW/year	220.0 MW	990 birds killed
Total birds estimated killed per year		**2352 birds**

Thus, the predicted figure for avian fatalities is 2352 birds from interactions with wind and solar farms within 50-km. If 36% of those at the wind farms are raptors (Perold et al. 2020), but none predicted for the solar farms (Visser et al. 2017) then we expect 490 raptor fatalities (0.36 x 1362) of which some (17%) may be threatened Red Data raptors amounting to 83 threatened raptors per year. These are high totals and suggest cumulative totals must be ranked *medium-high* and significant.

Nature: The impact of the Kleinsee solar energy facility proposed in the Kleinsee area is expected to be negative and arise from disturbance, displacement, and possibly collision for birds around the solar panels.
The direct potential impact of the **four wind farms and two solar farms** (Table 7) was gauged using a review of data in 2020 Birdlife South Africa for fatalities at 20 wind farms in South Africa (Perold et al. 2018).
About 4.6 birds per turbine per year, or 2.0 ± 1.3 birds per MW per year are killed annually at wind farms and 4.5 ± 3.5 birds per MW are killed at (one) solar farm (Visser et al. 2018).

If a total of 681.2 MW (wind) and 220 MW (solar) is generated per year from facilities within 50-km, we estimate about 2352 birds could be killed annually, of which 36% (of the wind farm victims, or 490 birds) are likely to be raptors. Since about 17% of these raptors are threatened Red Data species (Simmons and Martins 2018), about 83 threatened raptors are forecast to be killed (Table 7). Thus, the likely impact is forecast to **high** without mitigation – but careful mitigation can reduce this to medium levels.

	Contribution of Proposed Kleinsee solar farm project*	**Cumulative Impact Of all renewable projects within 50 km**
Extent	Local (1)	Regional (3)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (3)	High (9)
Probability	Medium Probability (3)	Probable (4)
Significance (E+D+M]P	**Low (24)**	**Medium-high (64)**
Status (positive/negative)	Negative	Negative
Reversibility	Medium	Medium
Loss of resources/species?	Unlikely	Likely
Can impacts be mitigated?	Probably, Yes	Yes

Confidence in findings:
Medium: the avian fatality data released by Birdlife South Africa and Visser et al. (2018) allows for the estimation of the probable avian mortality, but they may over-estimate avian mortality rates in the arid conditions typical in the north-western part of South Africa. Passage Rates and occurrence of Collision-prone species are typically low when annual rainfall is low, and mortality is thus expected to fluctuate with weather conditions and increase at times of high rainfall. The mitigation measures suggested to avoid major raptor fatalities is unknown for each of the wind farms in the Cumulative Assessment. Without mitigation measures (i.e., the avoidance of high-use and high-risk areas) the chances of mortality will increase greatly.
****With mitigation***

7.1.2 Other Power lines

Given the general assumption that power line length and bird impacts are linearly related, a starting point in determining cumulative impacts due to other power lines is to determine:

- the number of birds killed by collision with the extant power lines surrounding the site; and
- the length and size of the existing power lines within 50-km.

The number of lines, and their length, are given in Table 7. We have used bustards as a proxy for other species as they are among the most collision-prone species.

Table 7: All power lines within 50-km of the Kleinsee Solar PV Farm and associated (adjusted) bustard fatalities from similar size power lines (Shaw 2015).

	Power line	Voltage	Length within the 50-km radius	Rate of bustard deaths from same-size power lines	Estimated number of bustard deaths/y
1	Gromis-Juno	400 kV	99 km	1.05 b/km/y	104
2	Gromis-Kleinsee-Koiggnaas	66 kV	78 km	0.37 b/km/y	29
3	Kommagaas-Sandveld	66 kV	36 km	0.37 b/km/y	13
Totals: 3 OHPL (400kV + two 66kV) totalling 213-km are estimated to kill 146 bustards per year					

Given the following fatality rates associated with different sized power lines:

- transmission lines of > 220kV kill ~1.05 bustards/km/yr (Shaw 2013); and
- distribution lines of 66kV kill ~0.37 bustards/km/yr (Shaw 2013)

a cumulative total of 146 Red Data bustards per year are expected to be killed by these 400kV and 66 kV power lines per year. This is a high number and is thus classified of medium-high significance. Staggered pylon mitigations are recommended for all power lines in such areas.

8 MITIGATIONS

The small development footprint, Low Passage Rates of the Red Data birds and the medium-low Reporting Rates of all five Priority species, points to this proposed solar site as of low risk to the birds there. The greatest threat to avian species around a solar PV site are:

- Displacement from the area used for the panels;
- Loss of foraging habitat for threatened or Priority species;
- Wetland species perceiving the panels as open water and colliding with panels
- Collisions with the power lines.

The presence of only two threatened (Red Data) Priority species, and their low Passage Rates, and their relatively low likelihood of occurring, indicates that this site does not require any specific mitigations as the risks to the birds, or the loss of habitat, are both insignificant for this development.

Wetland birds that may perceive the solar panels as open water are generally confined to within 1-km of the coastal areas and, indeed, no cormorants or pelicans were recorded over the site in 24-hour observations over 2-months, despite their appearance in the SABAP records.

Moreover, there are no small, threatened lark species that fall within this area (either from our own surveys or from SABAP 2 data cards) that require protection due to possible habitat loss or displacement. That is, neither the Vulnerable Red Lark *Calendulauda burra*, nor the Near Threatened Barlow's Lark *Calendulauda barlowi,* occur in this area as it is too far north for the Red Lark and too far south for the Barlow's Lark.

9 ENVIRONMENTAL MANAGEMENT PROGRAMME

Given the possible impact of the proposed Kleinsee Solar farm development, the overall impact on avifaunal species requires systematic monitoring at both the construction-phase and operational-phase of the solar farm. This is a recommendation of the BARESG guidelines (Jenkins et al. 2015).

The guidelines suggest an adaptive and systematic monitoring of bird displacement (comparing avian densities before and after construction, particularly for Priority collision-prone and Red Data species) and particularly the monitoring of all turbine-related fatalities. The latter must take account of biases introduced by scavengers removing carcasses and observers failing to detect bird remains below the solar panels.

The monitoring should include the following (as per BARESG guidelines):

- Post-construction (operational phase) monitoring should be started as the solar farm facility (SEF) becom operational, bearing in mind that the effects of the SEF may change over time.
- Post-construction monitoring can be divided into two categories:
  a) quantifying bird numbers and movements (replicating baseline data collection), and
  b) estimating bird mortalities.
- Carcass monitoring should be undertaken by trained observers, willing to survey multiple panels per day in weathers over-seen by an ornithologist competent to determine species identification and a manager to colla and analyse each year's data.
- Estimating bird fatality rates includes:
  a) estimation of searcher efficiency and scavenger removal rates;
  b) carcass searches; and
  c) data analysis incorporating systematically collected data from (a) and (b); these biases should then allowed for in estimating fatality rates.
- A minimum of 40% of the solar farm footprint should be methodically searched for fatalities, throughout t year, with a search interval informed by scavenger removal trials and objective monitoring. Any evidence mortalities or injuries within the remaining area should be recorded and included in reports as incidental find
- The search area should be defined and consistently applied throughout monitoring.
- The duration and scope of post-construction monitoring should be informed by the outcomes of the previc year's monitoring and reviewed annually.
- Post-construction monitoring of bird abundance and movements and fatality surveys should span 2-3 years take inter-annual variation into account; and
- If significant problems are found or suspected, the post-construction monitoring should continue in conjuncti with adaptive management and mitigations – considering the risks related to the particular site and spec involved.

An assessment guided by these principles is required not only to enact and test the effectiveness of different mitigation measures where significant mortality occurs but allow data to be collected that will benefit the welfare of avifauna at other renewable energy farms. This is also important for a study of cumulative avian impacts for the increasing number of wind farms planned for South Africa.

Management interventions:

Where avian fatalities are found to occur **to *Red Data species*, or *at unacceptably high levels to Priority species***, then the additional mitigation measures detailed above, should be brought into play.

Thus, experiments, for example, with bird deterrent techniques should be undertaken within two months to reduce fatality rates. The results of these experiments should be publicised so that other wind farms, with similar issues, can be informed.

We would encourage Developers to release the results of the annual monitoring to Birdlife South Africa, such that South Africa-wide fatality and displacement results can be collated and assessed.

10 CONCLUSIONS AND RECOMMENDATIONS

Our desktop and two-season site visit of birds on the proposed Kleinsee Solar Energy Facility site indicates:

- A medium level of activity in terms of Passage Rates of Priority species (0.38 birds/hour), and medium activity of Red Data species (0.30 birds/hour).
- low overall species richness (46 species), and medium-low reporting rates for the four species of Priority birds.
- National Bird Atlas data (SABAP2) suggests that six Red Data species can occur in the area but only one of these were seen on this small site (Southern Black Korhaan).
- Screening Tool Assessment indicates a High risk in the Animal Theme but a low risk for the Avian theme.
- No small, threatened larks (*Vulnerable* Red Lark, or *Near Threatened* Barlow's Lark) were recorded on site.
- This suggests that the avian impact will be low for the proposed PV solar farm site at Kleinsee, but medium-high for the cumulative impacts
- The power lines exporting power to the grid pose a medium risk to the birds after mitigation, given their short length and the ability for the proposed line to be aligned and staggered with the existing Gromis-Juno line.
- Cumulative impacts are expected to medium-high due to the presence of highly collision-prone bustards.

Due to the low avian diversity, low Passage Rates, and paucity of highly threatened species on this small site, no mitigation measures are required for the solar farm. For the power lines however, the best form of mitigation is the staggered pylon idea (Pallett et al. 2022). An Environmental Management plan is given to survey the development area.

Since BBU found that the predicted impacts can be mitigated, we see no reason why the site should not be granted environmental authorisation from an avian perspective.

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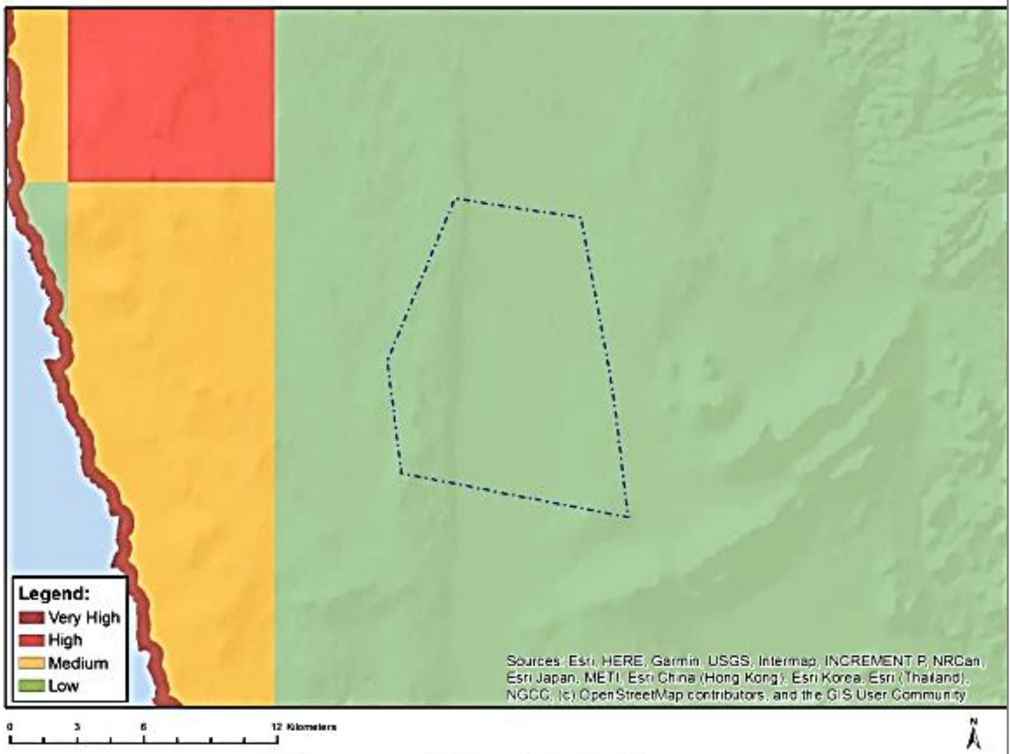
Date: 7 October 2022, Revised: 1 December 2022

APPENDIX 1:

DFFE SCREENING TOOL ASSESSMENT: **AVIAN THEME**

MAP OF RELATIVE AVIAN THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity

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APPENDIX 2: Bird species in the Kleinsee area

The 46 bird species recorded in and around the Kleinsee SEF in March and July 2022. This list amalgamates all surveys (i.e., 1-km transects and two Vantage Point surveys) and all months. The six **Red Data** species, and (3) other Priority collision-prone species are in **bold**.

Species List: Mar and Jul 2022 ALL ZONNEQUA SEFs	
African Black Swift	**Pale Chanting Goshawk**
African Stonechat	Pied Crow
Alpine Swift	Red-eyed Dove
Barn Swallow	Rufous-eared Warbler
Black-chested Snake Eagle	**Southern Black Korhaan**
Bokmakierie	Southern Double-collared Sunbird
Cape Clapper Lark	Southern Fiscal
Cape Crow	Speckled Pigeon
Cape Long-billed Lark	Spike-heeled Lark
Cape Penduline Tit	Spotted Thick-knee
Cape Sparrow	White-throated Canary
Cape Turtle Dove	Yellow Canary
Chat Flycatcher	**TOTAL: 46 species**
Chestnut-vented Tit-babbler	
Great White Pelican	
Greater Kestrel	
Grey Tit	
Grey-backed Cisticola	
Karoo Chat	
Karoo Eremomela	
Karoo Lark	
Karoo long-billed Lark	
Karoo Prinia	
Karoo Scrub-robin	
Kori Bustard	
Lanner Falcon	
Large-billed Lark	
Layard's Tit-babbler	
Little Swift	
Long-billed Crombec	
Ludwig's Bustard	
Malachite Sunbird	
Martial Eagle	
Namaqua Warbler	
Spike-heeled Lark	

Greater Kestrel

Ludwig's Bustard

APPENDIX 3: Safe and unsafe power pole designs

Examples of unsafe designs for power poles- causing electrocution (from *Electrocutions & Collisions of Birds in EU Countries: The Negative Impact & Best Practices for Mitigation* https://www.birdlife.org/wp-content/uploads/2022/10/Electrocutions-Collisions-Birds-Best-Mitigation-Practices-NABU.pdf

Examples of **dangerous power** lines with conductors placed above the support structures allowing birds such as the Long-crested Eagle (photo above taken in South Africa) to perch close to the live wires.

Two pathways are possible (below) for birds to be electrocuted (i) touching the two wires simultaneously and (ii) touching an earth and a conductor simultaneously.

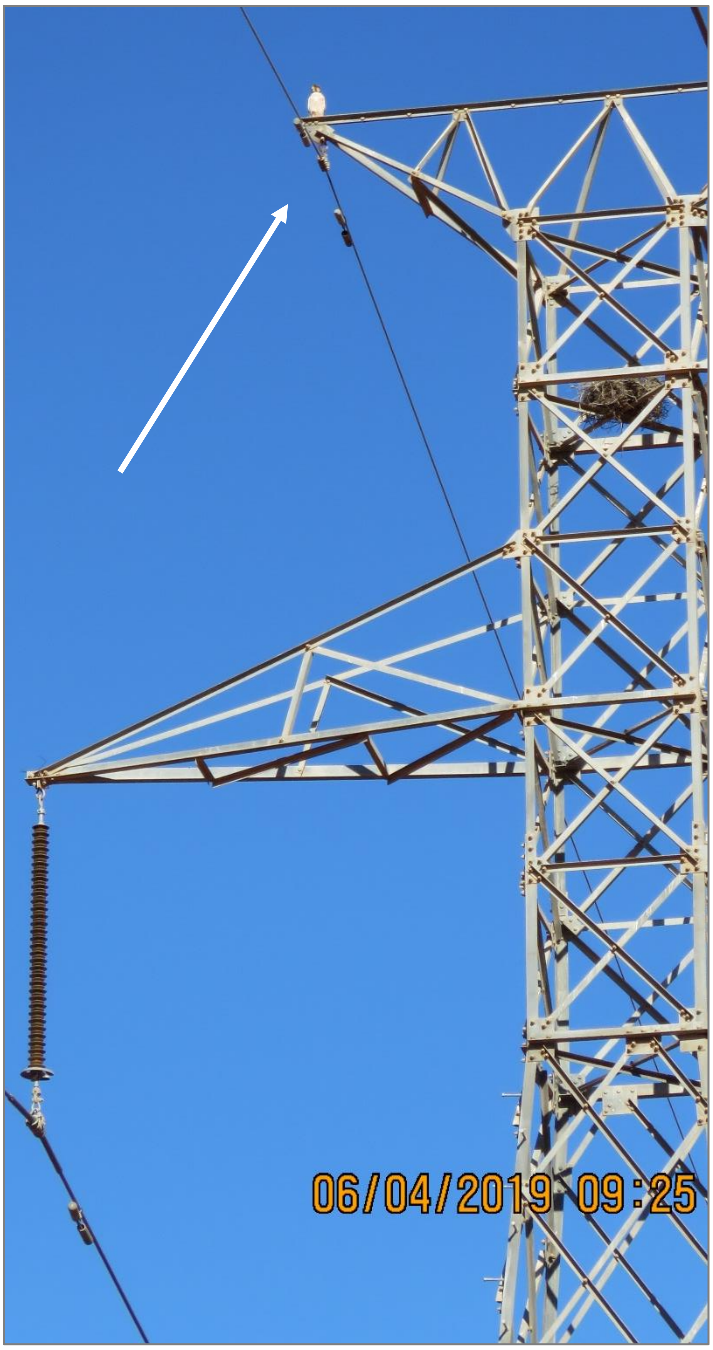
Southern Bulgaria'
[24]: Samusenko et al. (2012), 'The Problem of Bird Mortality on Power Lines in Belarus: Preliminary Results of Studies'
[25]: Demerdzhiev (2014), 'Factors Influencing Bird Mortality Caused by Power Lines within Special Protected Areas and Undertaken Conservation Efforts'
[11]: Demeter et al. (2018), 'Documenting and Reducing Avian Electrocutions in Hungary: a Conservation Contribution from Citizen Scientists'

Figure 4.1: Typical pattern of electrocution on medium voltage pole: (1) short–circuit; (2) earthed-fault.
Source: Raptor Protection of Slovakia

Examples of **safe support towers** with

conductors slung below the support arms

A Lanner Falcon perched above the conductors (arrowed right) cannot simultaneously contact the conductors and any earth. As such, larger or smaller birds cannot be electrocuted on designs where conductors are slung *below* the supporting structures.



APPENDIX 4: SABAP 2 RECORDS FROM 12 PENTADS AROUND THE KLEINSEE SEF SITE

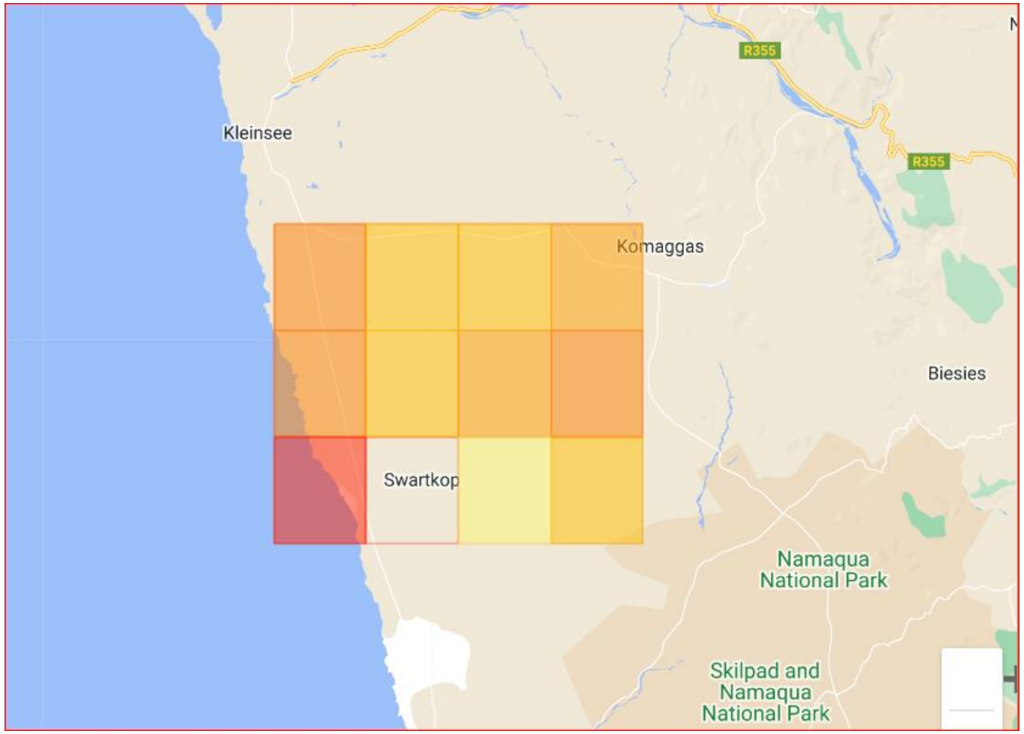
Common Name		Latin name		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Report Rate
Bokmakierie		Telophorus	zeylonus	42.9	66.7	54.5	100	83.3	50	85.7	62.5	50	100	20	56	57.9
Sanderling		Calidris	alba	0	66.7	50	0	50	0	0	0	0	0	75	80	45.7
Secretarybird		Sagittarius	serpentarius	0	0	28.6	0	0	0	0	100	0	0	17	0	12.5
Barbet	Acacia Pied	Tricholaema	leucomelas	0	0	0	0	0	0	50	66.7	0	0	0	0	30
Bee-eater	European	Merops	apiaster	0	0	0	0	0	0	0	0	0	100	100	0	16.7
Bulbul	Cape	Pycnonotus	capensis	0	100	0	0	100	0	0	25	0	100	0	100	60
Bunting	Cape	Emberiza	capensis	0	33.3	0	50	100	100	0	40	0	100	0	100	50
Bunting	Lark-like	Emberiza	impetuani	28.6	0	0	0	0	0	0	0	0	100	17	29	15.4
Bustard	Kori	Ardeotis	kori	0	33.3	50	0	0	0	0	50	0	0	0	40	24.2
Bustard	Ludwig's	Neotis	ludwigii	14.3	16.7	0	0	0	50	28.6	62.5	66.7	100	20	22	26.3
Buzzard	**Common**	Buteo	buteo	0	0	0	0	0	0	0	0	0	0	0	50	11.1
Buzzard	**Jackal**	Buteo	rufofuscus	0	0	12.5	0	33.3	0	0	20	100	50	0	20	14.6
Canary	Black-headed	Serinus	alario	50	0	0	0	0	0	0	0	0	0	0	0	11.1
Canary	White-throated	Crithagra	albogularis	57.1	50	18.2	0	50	50	57.1	37.5	0	50	20	25	33.3
Canary	Yellow	Crithagra	flaviventris	85.7	100	90.9	50	33.3	50	85.7	87.5	83.3	50	80	78	78.9
Chat	Ant-eating	Myrmecocichla	formicivora	14.3	25	50	0	33.3	0	0	0	20	0	50	29	28.8
Chat	Familiar	Oenanthe	familiaris	28.6	40	50	100	25	0	0	0	0	50	14	43	32
Chat	Karoo	Emarginata	schlegelii	0	33.3	0	100	66.7	0	0	40	0	0	0	0	26.1
Chat	Tractrac	Emarginata	tractrac	100	100	85.7	100	100	100	100	100	66.7	0	89	100	93.2
Cisticola	Grey-backed	Cisticola	subruficapilla	71.4	16.7	45.5	0	50	50	85.7	87.5	80	100	60	25	56.9
Cormorant	Cape	Phalacrocorax	capensis	40	33.3	50	0	50	100	100	0	0	0	75	40	51.4
Cormorant	Crowned	Microcarbo	coronatus	0	33.3	16.7	0	100	100	50	0	0	0	38	60	34.3
Cormorant	White-breasted	Phalacrocorax	lucidus	80	66.7	66.7	0	100	0	100	0	0	0	60	75	73.1
Crombec	Long-billed	Sylvietta	rufescens	28.6	33.3	9.1	0	33.3	0	28.6	25	100	100	40	22	31.5
Crow	Cape	Corvus	capensis	100	83.3	81.8	50	66.7	50	57.1	50	83.3	100	90	78	76.3
Crow	Pied	Corvus	albus	100	66.7	63.6	100	100	100	85.7	87.5	83.3	100	100	88	86.7
Dove	Cape Turtle	Streptopelia	capicola	0	66.7	0	50	33.3	0	66.7	28.6	66.7	0	0	100	37.1
Dove	Namaqua	Oena	capensis	50	50	0	0	0	0	0	33.3	0	0	0	25	21.1

Eagle	**Black-chested Snake**	Circaetus	pectoralis	42.9	0	27.3	0	20	0	66.7	33.3	0	50	17	14	27.6
Eagle	**Booted**	Hieraaetus	pennatus	0	0	0	0	0	0	0	75	0	100	0	100	37.5
Eagle	**Martial**	Polemaetus	bellicosus	0	0	33.3	0	0	0	0	0	0	0	0	0	7.7
Eagle	**Verreaux's**	Aquila	verreauxii	0	0	0	100	0	0	0	0	0	50	0	0	16.7
Eagle-Owl	Spotted	Bubo	africanus	14.3	0	0	50	0	0	33.3	0	0	100	0	33	14
Egret	Little	Egretta	garzetta	0	0	0	0	0	100	50	0	0	0	25	0	11.4
Eremomela	Karoo	Eremomela	gregalis	0	0	100	0	0	0	0	0	0	0	0	0	33.3
Eremomela	Yellow-bellied	Eremomela	icteropygialis	42.9	25	22.2	0	0	0	66.7	0	0	0	0	0	19.5
Falcon	**Lanner**	Falco	biarmicus	14.3	25	33.3	0	50	0	0	0	0	0	17	17	19.5
Fiscal	Southern	Lanius	collaris	0	16.7	9.1	100	33.3	0	66.7	12.5	0	0	14	14	19
Flamingo	**Greater**	Phoenicopterus	roseus	20	33.3	0	0	0	0	0	0	0	0	0	0	7.7
Flamingo	**Lesser**	Phoeniconaias	minor	0	0	0	0	0	0	0	0	0	0	100	0	11.1
Flycatcher	Chat	Melaenornis	infuscatus	42.9	66.7	36.4	50	66.7	50	71.4	50	66.7	50	30	38	49.3
Flycatcher	Fairy	Stenostira	scita	0	0	0	0	100	0	0	0	0	0	0	0	20
Francolin	Grey-winged	Scleroptila	afra	0	0	0	0	0	0	0	50	0	0	0	0	11.1
Gannet	Cape	Morus	capensis	0	0	0	0	0	0	0	0	0	0	40	0	7.7
Goose	Egyptian	Alopochen	aegyptiaca	0	0	0	0	50	100	0	0	0	0	0	0	5.7
Goshawk	**Pale Chanting**	Melierax	canorus	71.4	83.3	72.7	100	66.7	50	71.4	37.5	80	100	70	75	69.4
Greenshank	Common	Tringa	nebularia	0	0	0	0	0	0	0	0	0	0	40	25	11.5
Guineafowl	Helmeted	Numida	meleagris	0	0	0	0	0	0	0	0	0	0	0	50	11.1
Gull	Grey-headed	Chroicocephalus	cirrocephalus	0	0	0	0	0	0	100	0	0	0	0	0	11.1
Gull	Hartlaub's	Chroicocephalus	hartlaubii	40	33.3	33.3	0	50	100	100	0	0	0	75	60	51.4
Gull	Kelp	Larus	dominicanus	71.4	75	85.7	0	100	100	100	0	0	0	78	71	70.5
Harrier	**Black**	Circus	maurus	0	0	0	0	0	0	0	50	0	0	0	0	11.1
Harrier-Hawk	African	Polyboroides	typus	0	0	0	0	50	0	0	0	0	0	0	0	11.1
Heron	Black-headed	Ardea	melanocephala	80	66.7	100	0	50	0	0	0	0	0	20	75	65.4
Heron	Grey	Ardea	cinerea	100	100	100	0	50	100	100	0	0	0	63	100	80
Ibis	Hadada	Bostrychia	hagedash	0	0	0	0	0	0	50	0	0	0	0	0	20
Kestrel	**Greater**	Falco	rupicoloides	100	66.7	60	0	40	100	80	57.1	60	0	80	88	70.1
Kestrel	**Lesser**	Falco	naumanni	0	0	0	0	0	0	0	0	0	100	0	0	11.1
Kestrel	Rock	Falco	rupicolus	71.4	50	44.4	0	20	0	50	33.3	0	0	33	63	41

Kite	**Yellow-billed**	Milvus	aegyptius	0	0	0	0	0	0	0	0	0	100	0	0	11.1
Korhaan	**Southern Black**	Afrotis	afra	28.6	83.3	60	50	50	100	50	28.6	0	50	11	0	37.7
Lapwing	Crowned	Vanellus	coronatus	0	0	0	0	0	0	0	0	50	0	50	0	16.7
Lark	Cape Clapper	Mirafra	apiata	0	50	66.7	0	25	0	75	50	0	50	0	0	44
Lark	Cape Long-billed	Certhilauda	curvirostris	100	83.3	63.6	100	100	100	85.7	50	83.3	50	100	100	84.2
Lark	Karoo	Calendulauda	albescens	14.3	33.3	63.6	100	83.3	100	71.4	75	100	100	60	56	64.5
Lark	Karoo Long-billed	Certhilauda	subcoronata	0	0	100	0	0	0	0	0	0	0	0	0	33.3
Lark	Large-billed	Galerida	magnirostris	50	33.3	33.3	100	33.3	0	33.3	33.3	50	50	25	75	42.1
Lark	Red-capped	Calandrella	cinerea	57.1	75	75	100	50	100	0	0	0	0	33	71	51.1
Lark	Spike-heeled	Chersomanes	albofasciata	28.6	33.3	10	0	83.3	50	0	14.3	80	0	40	63	36.2
Martin	Brown-throated	Riparia	paludicola	0	0	14.3	100	0	0	0	0	0	0	0	0	5.7
Martin	Rock	Ptyonoprogne	fuligula	14.3	33.3	36.4	50	50	50	57.1	62.5	50	100	20	0	37.3
Mousebird	Red-faced	Urocolius	indicus	0	0	0	0	0	0	66.7	0	0	0	0	100	33.3
Mousebird	White-backed	Colius	colius	50	50	0	0	100	0	66.7	25	0	50	25	0	27.3
Ostrich	Common	Struthio	camelus	100	75	71.4	0	100	100	100	0	33.3	0	78	100	79.5
Oystercatcher	African	Haematopus	moquini	0	0	0	0	0	0	100	0	0	0	0	25	7.7
Pigeon	Speckled	Columba	guinea	0	0	50	100	0	0	0	50	0	0	0	100	41.7
Pipit	African	Anthus	cinnamomeus	50	0	0	0	0	0	0	100	0	0	0	0	22.2
Plover	Common Ringed	Charadrius	hiaticula	0	0	0	0	50	0	0	0	0	0	20	0	7.7
Plover	Kittlitz's	Charadrius	pecuarius	0	33.3	0	0	0	0	0	0	0	0	0	0	3.8
Plover	White-fronted	Charadrius	marginatus	100	100	100	0	100	100	100	0	0	0	88	100	88.6
Prinia	Karoo	Prinia	maculosa	85.7	50	63.6	100	83.3	50	85.7	87.5	100	50	50	67	72.4
Quail	Common	Coturnix	coturnix	0	0	0	0	0	0	0	100	0	0	0	0	11.1
Raven	White-necked	Corvus	albicollis	0	0	100	100	0	0	33.3	40	0	0	0	0	27.3
Robin-Chat	Cape	Cossypha	caffra	0	0	0	0	0	0	0	0	100	0	0	0	33.3
Sandgrouse	Namaqua	Pterocles	namaqua	50	100	100	0	0	0	0	0	33.3	100	50	0	40
Sandpiper	Common	Actitis	hypoleucos	0	0	0	0	0	0	0	0	0	0	20	0	3.8
Sandpiper	Curlew	Calidris	ferruginea	0	0	0	0	0	0	0	0	0	0	0	25	3.8
Scrub Robin	Karoo	Cercotrichas	coryphoeus	85.7	83.3	81.8	0	50	100	57.1	62.5	80	100	50	78	69.9

Shelduck	South African	Tadorna	cana	40	33.3	50	0	100	0	50	0	0	0	0	0	25.7
Sparrow	Cape	Passer	melanurus	71.4	66.7	72.7	50	66.7	50	100	62.5	66.7	50	60	67	68.4
Sparrow	House	Passer	domesticus	0	0	0	100	0	0	0	100	0	0	0	0	22.2
Sparrow-Lark	Black-eared	Eremopterix	australis	50	0	0	0	0	0	0	0	0	0	100	0	22.2
Sparrow-Lark	Grey-backed	Eremopterix	verticalis	28.6	0	0	0	0	0	0	0	0	0	0	29	11.1
Starling	Common	Sturnus	vulgaris	0	0	0	0	0	0	0	100	0	0	0	0	11.1
Starling	Pale-winged	Onychognathus	nabouroup	0	0	0	0	50	0	0	0	0	0	0	0	11.1
Starling	Pied	Lamprotornis	bicolor	40	0	0	0	0	0	0	0	0	0	0	25	11.5
Stint	Little	Calidris	minuta	0	0	16.7	0	0	0	0	0	0	0	0	0	3.8
Stonechat	African	Saxicola	torquatus	100	100	81.8	0	100	100	57.1	33.3	0	0	56	63	67.2
Sunbird	Dusky	Cinnyris	fuscus	0	20	11.1	0	40	0	50	0	0	0	17	14	16.3
Sunbird	Malachite	Nectarinia	famosa	0	0	0	0	16.7	100	66.7	85.7	60	0	0	25	26.1
Sunbird	Southern Double-collared	Cinnyris	chalybeus	57.1	16.7	27.3	100	66.7	50	71.4	100	83.3	100	50	13	54.7
Swallow	Barn	Hirundo	rustica	100	100	100	0	0	0	0	0	0	0	70	88	59.3
Swallow	Pearl-breasted	Hirundo	dimidiata	50	0	0	0	0	0	0	0	0	0	0	0	11.1
Swallow	White-throated	Hirundo	albigularis	20	0	0	0	0	0	0	0	50	0	0	0	6.9
Swift	Alpine	Tachymarptis	melba	28.6	0	0	0	25	100	60	40	83.3	50	10	0	24.6
Swift	Bradfield's	Apus	bradfieldi	0	0	0	0	50	0	0	0	0	0	0	0	11.1
Swift	Common	Apus	apus	50	0	0	0	0	0	0	0	50	0	0	33	23.1
Swift	Little	Apus	affinis	50	0	50	0	50	0	100	33.3	100	0	100	0	42.9
Swift	White-rumped	Apus	caffer	50	0	0	0	0	0	50	0	0	0	0	33	20
Tern	Caspian	Hydroprogne	caspia	0	0	0	0	0	0	0	0	0	0	0	50	7.7
Tern	Common	Sterna	hirundo	0	0	16.7	0	50	0	0	0	0	0	20	0	11.5
Tern	Greater Crested	Thalasseus	bergii	20	33.3	0	0	50	100	100	0	0	0	50	0	28.6
Tern	Sandwich	Thalasseus	sandvicensis	40	33.3	0	0	0	0	0	0	0	0	63	0	22.9
Thick-knee	Spotted	Burhinus	capensis	14.3	20	12.5	100	33.3	0	33.3	0	20	0	40	29	23.6
Tit	Cape Penduline	Anthoscopus	minutus	57.1	20	27.3	0	20	0	66.7	0	50	0	29	38	32.2
Tit	Grey	Melaniparus	afer	57.1	33.3	20	100	16.7	50	16.7	71.4	0	50	44	50	39.1
Turnstone	Ruddy	Arenaria	interpres	0	33.3	0	0	50	0	0	0	0	0	0	0	7.7
Wagtail	Cape	Motacilla	capensis	85.7	50	85.7	0	100	100	100	0	0	0	78	71	70.5
Warbler	Chestnut-vented	Curruca	subcoerulea	50	0	25	0	0	0	75	0	100	50	0	0	24.1
Warbler	Cinnamon-breasted	Euryptila	subcinnamomea	0	0	0	0	50	0	0	0	0	0	0	0	11.1

Warbler	Layard's	Curruca	layardi	0	0	0	0	20	0	57.1	60	100	100	11	14	27.1
Warbler	Namaqua	Phragmacia	substriata	50	0	0	0	0	0	0	0	0	0	100	0	22.2
Warbler	Rufous-eared	Malcorus	pectoralis	42.9	50	72.7	50	33.3	50	57.1	62.5	33.3	50	40	56	51.3
Weaver	Cape	Ploceus	capensis	0	25	0	0	0	0	0	100	0	0	0	0	5.7
Wheatear	Capped	Oenanthe	pileata	28.6	50	42.9	0	100	100	0	0	20	0	20	43	34
Wheatear	Mountain	Myrmecocichla	monticola	0	0	0	50	100	0	0	40	0	50	0	67	34.6
Woodpecker	Ground	Geocolaptes	olivaceus	0	0	0	0	33.3	0	0	50	0	0	0	0	21.4
TOTALS	**127 species**															



The 12 pentads from the SABAP 2 scheme used to generate a list of bird species likely to be found in the Kleinsee solar Energy facility, centrally placed in the pentads.

Colours represent the number of cards posted for each pentad: from 1 card (pale yellow) to 26 cards (purple)