ARCUS

DASSIESRIDGE WIND ENERGY FACILITY
EA AMENDMENT REPORT

BAT ASSESSMENT

On behalf of

CES – Environmental and Social Advisory Services

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Prepared By:

Arcus Consultancy Services South Africa (Pty) Limited

Office 220 Cube Workspace
Icon Building
Cnr Long Street and Hans Strijdom Avenue
Cape Town
8001

T +27 (0) 21 412 1529 l **E** AshlinB@arcusconsulting.co.za
W www.arcusconsulting.co.za

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1 INTRODUCTION

Dassiesridge Wind Power (Pty) Ltd ("the applicant") received environmental authorisation for the Dassiesridge Wind Energy Facility (WEF) on 18 May 2016 (which was subsequently amended on 13 February 2017). The applicant is proposing to amend the turbine specifications for the Dassiesridge Wind Energy Facility as follows:

- Increase the rotor diameter from 132 m to up to 175 m (i.e. increase blade length from 66 m to up to 87.5 m)
- Hub height increase from 137 m to up to 137 m
- Reduce the number of turbines from 67 to 47
- Increase the concrete foundations size from 20 m x 20 m to 30 m x 30 m
- Increase the hard standing area from 2800 m^2 to 3600 m^2

1.1 Terms of Reference

The report has been compiled under the following terms of reference and provides:

- An assessment of all impacts related to the proposed changes;
- Advantages and disadvantages associated with the changes;
- Comparative assessment of the impacts before the changes and after the changes; and
- Measures to ensure avoidance, management and mitigation of impacts associated with such proposed changes, and any changes to the EMPr.

2 METHODOLOGY

In carrying out this assessment, Arcus conducted a literature review on bats and wind energy impacts with a focus on the relationship between turbine size and bat fatality. The literature review was carried out using the Web of Science® and Google Scholar using the following search terms:

bat OR fatality OR wind energy OR turbine OR wind turbine OR fatalities OR mortality OR mortalities OR kill* OR tower height OR height OR rotor swept zone OR rotor zone OR rotor swept area OR blades OR turbine blades OR influence OR increas* OR trend OR positive OR decreas* OR relation* OR wind farm OR wind energy facility OR carcass* OR chiroptera OR rotor diameter OR correlat* OR size*

To compare the current assessed impacts of the Dassiesridge WEF to those related to the proposed changes, the final environmental impact report (December 2015) was reviewed. The environmental management plan was also reviewed to assess the current mitigation measures that are to be adhered to. In addition, all relevant Environmental Authorisations and the pre-construction bat monitoring report for the Dassiesridge WEF were reviewed. The monitoring was conducted between February 2014 and February 2015. Finally, to assist with the cumulative impact assessment, information from neighbouring developments was obtained which included from the Motherwell, Ukomoleza, Grassridge, Coega Sonop and Coega Universal wind energy projects. An additional project, Coega West wind farm is located near to the proposed Dassiesridge wind farm but no information was available.

3 REVIEW

The core issue relevant to this assessment is the impact to bats of amending the size of the turbines at the Dassiesridge WEF. Currently, the rotor swept area for each turbine will be 13,685 m^2 assuming turbines with blade lengths of 66 m. The amendment would result in an increase of the rotor swept area to 24,053 m^2 assuming turbines with blade lengths of 87.5 m. The minimum and maximum tip heights currently approved will be 71 m and 203 m respectively.

Numerous studies support the hypothesis that taller wind turbines are associated with higher numbers of bat fatalities. Rydell et al. (2010) found a significant positive correlation between bat mortality with both turbine tower height and rotor diameter in Germany. However, there was no significant relationship between bat mortality and the minimum distance between the rotor and the ground. The maximum tower height in their study was 98 m and data on rotor diameter were not given. In addition, there was no relationship between bat fatality and the number of turbines at a wind energy facility.

In Greece, Georgiakakis et al. (2012) found that bat fatalities were significantly positively correlated with tower height but not with rotor diameter. In their study, maximum tower height and rotor diameter were 60 m and 90 m respectively. In Minnesota and Tennessee, USA, both Johnson et al. (2003) and Fiedler et al. (2007) showed that taller turbines with a greater rotor swept area killed more bats. The maximum heights of turbines in these two studies were 50 m and 78 m respectively. In Alberta, Canada, bat fatality rates differed partly due to differences in tower height but the relationship was also influenced by bat activity (Baerwald and Barclay 2009). For example, sites with high activity but relatively short towers had low bat fatality and sites with low activity and tall towers also had low bat fatality. At sites with high bat activity, an increase in tower height increased the probability of fatality. Maximum turbine height and rotor diameter in this study was 84 m and 80 m respectively. Despite the above support for the hypothesis that taller wind turbines kill more bats, in a review of 40 published and unpublished studies in North America, Thompson et al. (2017) found no evidence that turbine height or the number of turbines influences bat mortality. Berthinussen et al. (2014) also found no evidence of modifying turbine design to reduce bat fatalities. The relationship between bat mortality and turbine size, or number of turbines at a wind energy facility, is therefore equivocal.

Turbine size has increased since the above studies were published and no recent data of the relationship between bat fatality and turbine size are available. The maximum size of the turbines in the literature reviewed (where indicated in each study) for this assessment had towers of 98 m and rotor diameters of 90 m. Some towers were as short as 44 m and had blade tips extending down to only 15 m above ground level.

It is possible that some bats species, particularly those not adapted to use open air spaces, are being killed at the lower sweep of the turbine blades so having a shorter distance between the ground and the lowest rotor tip point may have a negative impact and potentially place a greater diversity of species at risk. Higher hub height and longer blades can intrude more into the higher air space and possibly have a negative impact on free-tailed bats. In South Africa, evidence of fatality for species which typically do not forage in open spaces high above the ground, is available from several wind energy facilities (Aronson et al. 2013; Doty and Martin 2012; MacEwan 2016). Although Rydell et al. (2010) did not find a significant relationship between bat mortality and the minimum distance between the rotor and the ground, data from Georgiakakis et al. (2012) suggest that as the distance between the blade tips and the ground increases, bat fatality decreases.

It is not known what the impact of the size of turbines proposed for the Dassiesridge WEF would be to bats because of a lack of published data from wind energy facilities with turbines of a comparative size. Hein and Schirmacher (2016) suggest that bat fatality should continue to increase as turbines intrude into higher airspaces because bats are known to fly at high altitudes (McCracken et al. 2008; Peurach et al. 2009; Roeleke et al. 2018). However, McCracken et al. (2008), who recorded free-tailed bats in Texas from ground level up to a maximum height of 860 m, showed that bat activity was greatest between 0 and 99 m. This height band accounted for 27 % of activity of free-tailed bats, whereas the 100 m to 199 m height band only accounted for 6 %.

In South Africa, simultaneous acoustic monitoring at ground level and at height is a minimum standard for environmental assessments at proposed wind energy facilities.

Based on unpublished data from 18 such sites Arcus has undertaken pre-construction monitoring at, bat activity and species diversity is greater nearer ground level than at height. Therefore, even though bats are recorded at heights that would put them at risk from taller turbines, the proportion of bats that would be at risk might be less. Further, the number of species that might be impacted would decrease because not all bat species use the airspace congruent with the rotor swept area of modern turbines owing to morphological adaptations related to flight and echolocation. Bats that are adapted to use open air space, such as free-tailed and sheath-tailed bats, would be more at risk.

In the United Kingdom, both Collins and Jones (2009) and Mathews et al. (2016) showed that fewer species, and less activity, were recorded at heights between 30 m and 80 m compared to ground level. In two regions in France, Sattler and Bontadina (2005) recorded bat activity at ground level, 30 m, 50 m, 90 m and 150 m and found more species and higher activity at lower altitudes. Roemer et al. (2017) found that at 23 met masts distributed across France and Belgium, 87 % of bat activity recorded was near ground level. However, the authors also showed a significant positive correlation between a species preference for flying at height and their collision susceptibility, and between the number of bat passes recorded at height and raw (i.e. unadjusted) fatality counts. In a similar study in Switzerland, most bat activity was recorded at lower heights for most species but the European free-tailed bat had greater activity with increasing height (Wellig et al. 2018).

4 IMPACT ASSESSMENT

4.1 Effect of the Amendment on Current Impacts

Of the impacts identified in the EIA (December 2015), only mortality of species due to collision with turbine blades or due to barotrauma are relevant to this amendment. The significance of all other identified impacts on bats associated with the development will remain the same as per the EIA. The potential significance of bat mortality was rated as high before, and moderate after mitigation. The assessment is based on field data collected between February 2014 and February 2015 during the pre-construction monitoring and environmental authorisation was obtained in May 2016.

Based on our review of the pre-construction monitoring data, bat fatality at the operational Grassridge wind farm, bat activity from the four other nearby sites, and the relationship between bat fatality and turbine size, the proposed amendment would result in an increase in impacts to bats during the operational phase. Primary reasons for this increase are the relatively high activity of high risk bat species at the site and because of the greater rotor swept area. However, the current impacts are already rated as high before mitigation (and therefore would not increase further) and moderate after mitigation. While the overall impacts might not be changing, the risk/likelihood without mitigation will increase from "probable" to "definite", and the severity of the impact with mitigation will increase from "slight" to "moderate".

The applicant is undertaking this amendment to allow for flexibility in choosing the size of the turbines. This choice will presumably be made based on the wind regime at the site and the availability of cost effective wind turbines. However, this flexibility makes it difficult to assess impacts because turbines of different size may have different impacts. For example, based on fatality data from two locations in the Coega IDZ, the Cape serotine has suffered mortality at turbines with varying size.

At Grassridge, the turbine blades sweep down to 28 m above the ground, while at the single Electrawinds turbine, the blades sweep down to 50 m above the ground. The fatality data from these two facilities suggest that the Cape serotine is capable of flying to at least 50 m. It has also be recorded flying at higher heights but its activity levels appear to decline exponentially with height (Arcus, unpublished data). Therefore, to limit impacts to the Cape serotine, a minimum blade tip height of at least 45 m must be used and the impact assessment assumes this. If the blades sweep down closer to the ground, the associated impacts would be higher. An appropriate combination of hub height and rotor diameter will therefore need to be selected to order to limit the blade sweep to 45 m above the ground. Apart from the minimum blade sweep, it is also important to select a blade length that limits impacts to higher flying species.

Higher flying species that may occur in the greater study area include the Egyptian free-tailed bat, Mauritian tomb bat, Egyptian rousette, Wahlberg's epauletted fruit bat, Little free-tailed bat and Angolan free-tailed bat. The Egyptian free-tailed bat, Mauritian tomb bat and Little free-tailed bat have been confirmed to occur in the study area. The pre-construction monitoring data showed that at 50 m the Egyptian free-tailed bat accounted for 90 % of the activity. It was also the most commonly recorded species at height at other projects in the Coega IDZ. However, there are no data above 90 m in the area for any of these species so it if difficult to determine what length to limit the blades. In addition, all of these species may be active across most of the rotor swept zone so it is impractical to assign specific turbine dimensions for high flying species. Therefore, alternative measures to reduce impacts to high flying species, such as curtailment, will be needed.

Table 1: Updated Impact of the Dassiesridge WEF on Bats

RATING		Temporal Scale		Spatial Scale		Severity of Impact		Risk or Likelihood		Total
	Without Mitigation	Long term	3	Study Area	2	Severe	4	Definite	4	13
	With Mitigation	Long term	3	Study Area	2	Moderate	2	May Occur	2	9
Overall Significance without mitigation										High -
Overall Significance with mitigation										Moderate -

4.2 Effect of the Amendment on Mitigation Measures

The main mitigation measures proposed in the final EIA from December 2015 was restricting turbine operating times (i.e. curtailment). This has not been carried through into the draft environmental management plan (EMP), November 2015. The final EMP must therefore be updated to include the curtailment plan outlined in the pre-construction bat monitoring report. This is a measure to minimise potential residual impacts as opposed to avoiding impacts in the first instance.

The main avoidance measure is siting turbines away from important bat habitats. The pre-construction monitoring report defined areas in the study area as either moderate or high sensitivity for bats. Moderate sensitivity areas were buffered by 100 m, while high sensitivity areas were buffered by 200 m or 500 m (depending on the respective feature being buffered). However, current best practise requires a minimum buffer of 200 m for all important bat features. Therefore, the moderate sensitivity buffer of 100 m will need to be increased to 200 m.

While not explicitly stated in the pre-construction monitoring report, all buffers must be to blade tip. To determine the buffer distances required to ensure that no turbine blades enter the bat buffers, the following formula was used (Mitchell-Jones and Carlin 2014):

$$b = \sqrt{(bd + bl)^2 - (hh - fh)^2}$$

Where: bd = buffer distance, bl = blade length, hh = hub height and fh = feature height (zero in this instance)

The exact turbine dimensions are not known so a worst case scenario was used to update the bat buffer areas. A turbine with a low hub height (110 m) and with the maximum blade length being applied for (87.5 m) was used. Such a turbine would have a ground clearance of 22.5 m. Based on this, the turbine base must be 266 m from both the moderate and high sensitivity bat areas and 577 m from confirmed roost sites so that the turbine blades themselves are 200 m and 500 m away respectively. Only turbine, WTG 07, falls within a moderate sensitivity buffer and must be prioritised during operational monitoring. It may be subjected to additional mitigation if bat mortalities are found to be unacceptably high.

Increasing evidence suggests that bats actively forage around wind turbines (Cryan et al. 2014; Foo et al. 2017). The installation of turbines in the landscape may therefore alter bat activity patterns, either by increasing activity at height and/or increasing the diversity of species making use of higher airspaces. Therefore, there may still be residual impacts after these avoidance measures and additional mitigation measures may be needed to minimise residual impacts. Turbine design can help to reduce residual impacts.

Since bat activity and species composition tends to be greater and more diverse respectively at lower altitudes, maximising the lower blade tip height is preferable. This could be achieved by having either shorter blades, a higher hub height, or both. However, adjusting the hub height alone would not limit impacts to higher flying species, and a higher hub height would be detrimental to high risk species despite possibly being beneficial to lower flying species. A lower hub height would decrease blade intrusion into higher airspaces and reduce the potential impact to high flying species such as free-tailed bats, but depending on blade length, might increase impacts to lower flying species. It would therefore be preferential, for both high flying and lower flying species, to reduce rotor swept area by having shorter blades. It is difficult to determine an appropriate turbine size that would reduce impacts to both high and low flying species and as such it is likely that additional residual impacts would occur. Beyond turbine design, more active mitigation to reduce these residual impacts will be needed and curtailment is an available option.

Curtailment is included as a mitigation measure in the EIA (December 2015). Curtailment is the most effective way to reduce residual impacts to bats (Arnett and May 2016; Hayes 2019) whereas deterrent technology is still in testing stages and its effect on reducing bat fatality less known (Arnett 2013). The amendment to the turbine specifications may increase the probability that curtailment will need to be used, especially if a larger rotor swept area is used, and the hub height lowered. A detailed curtailment plan is included in the pre-construction monitoring report. The curtailment plan must be adhered to and the EMP must be updated to include the details it contains so that it can be implemented by the wind farm operator. Carcass searching must take place during the operational phase for at least two years and these data must be used to refine the curtailment plan in an adaptive manner. This could result in changes to the curtailment regime such as the date and time periods under which curtailment is needed. Alternatively, or in conjunction with curtailment, deterrents can be tested to determine if they are successful in reducing bat fatalities.

4.3 Effect of the Amendment on Current EA Conditions

The amendment will result in a greater rotor swept area and there will likely be residual impacts to bats after avoidance measures are implemented. These residual impacts will result in bat mortality and curtailment is required to reduce these impacts. Therefore, the EA and EMP need to be amended to include a condition that curtailment for bats must be implement following the recommendations in the pre-construction bat monitoring report. The EA and EMP must also stipulate that the curtailment regime must be continually assessed and adapted in response to bat fatality levels.

The pre-construction bat monitoring report stated that blade feathering must be used as the initial curtailment regime. This would need to be implemented during certain time and date periods (Table 2), and continue for at least two years, in parallel with operational carcass search monitoring. The curtailment regime should be adapted based on incoming bat mortality and activity data, and, if needed, the environmental conditions in Table 2 can be used to refine the curtailment regime.

Table 2: Dassiesridge Curtailment Plan

Period	Times	Environmental Conditions
1 January – 15 February	Sunset – 04:00	0 – 7.5 m/s; Above 17 °C (measured at 50m agl)
Turbines to be Curtailed	WTG1, WTG7, WTG8, WTG12, WTG18, WTG21, WTG24, WTG25, WTG26, WTG27, WTG32, WTG33, WTG35, WTG36, WTG46, WTG47, WTG49, WTG51, WTG53, WTG54, WTG56, WTG63, WTG64, WTG65, WTG67, WTG68, WTG69	

4.4 Effect of the Amendment on Cumulative Impacts

No cumulative impact assessment was done for bats in the EIA (2015). There are two operational facilities in the assessment area (the Grassridge and Van Stadens WEFs), defined as a 50 km radius around the proposed WEF, and at least six proposed facilities that we are aware of (Sonop, Universal, Coega West, Motherwell, Ukomeleza, and a confidential WEF). In addition, there is a cluster of proposed and operational wind farms approximately 75 km west of Dassiesridge including the operational Jeffreys Bay, Oyster Bay, Gibson Bay, Kouga and Tsitsikama Community wind farms. The Cookhouse Renewable Energy Development Zone is located approximately 65 km north which includes the operational Waainek, Cookhouse, Golden Valley, Nojoli, Nxuba and Amakhala Emoyeni wind farms, as well as several proposed wind farms.

Information on bat fatality in these areas is difficult to obtain from all facilities but for those from which data are available, the impacts to bats at some are high. The introduction of another wind farm, particularly one with turbines with larger rotor swept areas is likely to have a very high negative cumulative impact to the bat community in these areas. With mitigation measures, these impacts could reduce to moderate but may still be high depending on the success of the mitigation measures at each of the wind farms in the cumulative impact assessment area. The moderate rating therefore assumes that all wind farms will apply and adhere to appropriate mitigation, which may not occur.

Table 1: Cumulative Impacts of the Dassiesridge WEF on Bats

RATING		Temporal Scale		Spatial Scale		Severity of Impact		Risk or Likelihood		Total
	Without Mitigation	Long term	3	Regional	3	Very Severe	8	Definite	4	18
	With Mitigation	Long term	3	Regional	3	Moderate	3	May Occur	2	11
Overall Significance without mitigation										Very High -
Overall Significance with mitigation										Moderate -

5 CONCLUSION

Compared to the previous impact assessment undertaken in 2015, it is likely that the amendments to the turbine dimensions proposed for the Dassiesridge WEF will increase the current rated impacts to bats. Cumulative impacts were not previously assessed and will be very high before, and moderate, after mitigation.

The primary mitigation is to avoid impacts which can be achieved through appropriate turbine siting. The buffers have been increased to a minimum of 266 m from those proposed in the pre-construction bat monitoring to meet current best practise standards. No turbines are located within bat sensitive areas, except for one turbine in the moderate sensitivity zone. There will still be residual impacts to bats because bat activity is high during certain time periods and for certain species. Turbine design can reduce these impacts and the blades must not sweep down further than 45 m above ground level. There will still be additional residual impacts even with these design parameters because it is difficult to select a competitive turbine that limits impacts to both low and high flying species. Curtailment must therefore be used as described in the pre-construction bat monitoring report from the start of operation of the facility. If these mitigation measures are adhered to, the specialist accepts the proposed amendments.

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