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Appendix D12:

Socio-Economic Assessment of the Potential Wake Effects

SOCIO-ECONOMIC ASSESSMENT OF THE POTENTIAL WAKE EFFECTS OF THE PROPOSED BOTTERBLOM WIND ENERGY FACILITY (WEF) ON THE EXISTING LOERIESFONTEIN AND KHOBAB WEFs AND PROPOSED KOKERBOOM 1,2, 3 AND 4 WEFs

Draft report

February 2022

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DOCUMENT INFORMATION

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Brief profile: Elena Broughton is a specialist advisor to Urban-Econ Development Economists and Urban-Econ:NIKELA. She has extensive knowledge in various fields of economic development that includes 16 years of experience in undertaking socio-economic impact assessment studies for a variety of private clients spanning the mining, manufacturing, energy, infrastructure, and retail sectors. She also acted as a peer reviewer in several socio-economic impact assessment studies and completed a few strategic socio-economic impact assessments. Her involvement in the field allowed her to develop a sound understanding of the South African environmental legislation and developmental policies and equipped her with a widespread knowledge of socio-economic implications and benefits of various new developments.

SPECIALISTS DECLARATION

I, Elena Broughton declare that--:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- 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 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;
- all the particulars furnished by me in this form 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.

Signature of the specialist:

Elena Broughton

Specialist Advisor for Urban-Econ Development Economists and Urban-Econ:NIKELA

Date: 28 February 2022

CONTENTS

ACRONYMS AND ABBREVIATIONS

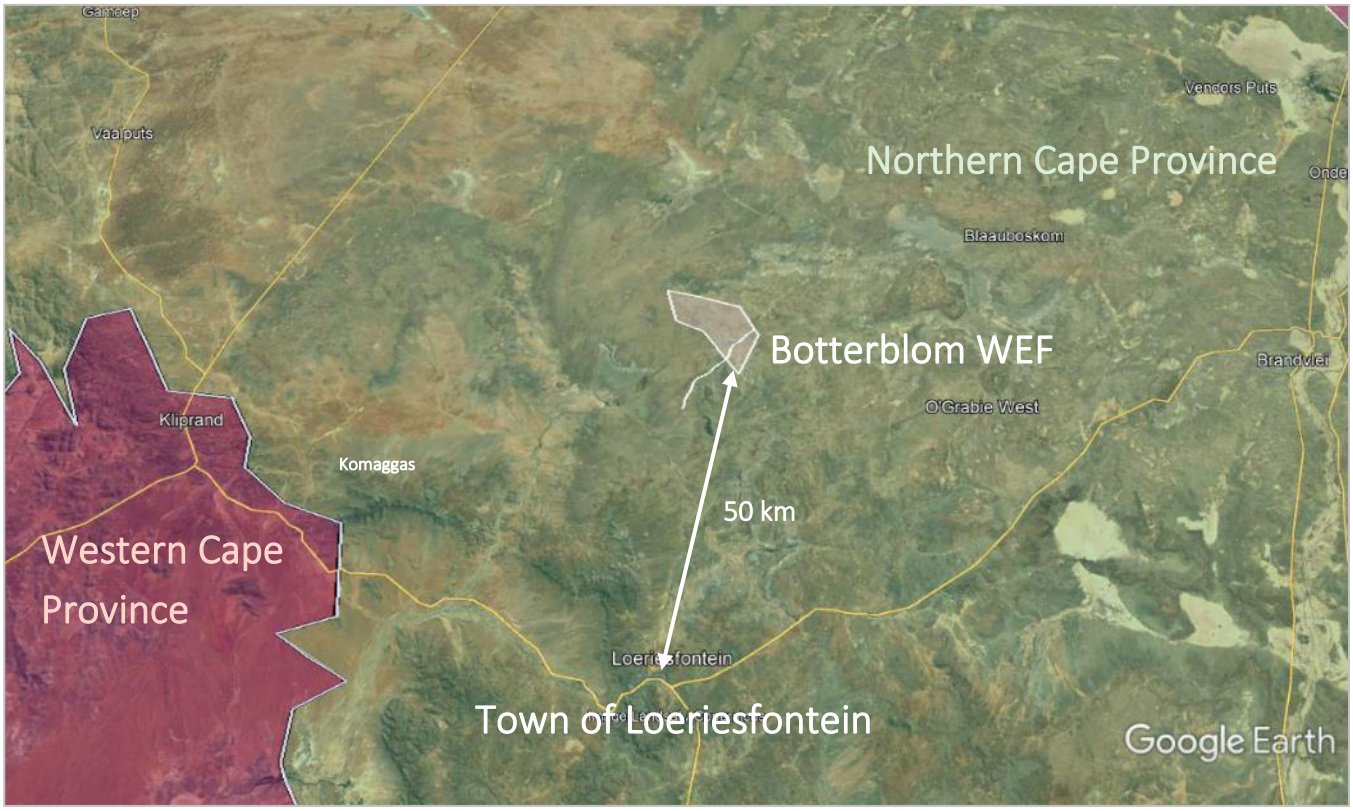
CD	Community Development
CF	Capacity Factor
CFI	Consumer Price Index
DMRE	Department of Mineral Resources and Energy
ED	Enterprise Development
IPP	Independent Power Producer
MW	Megawatt
MWh	Megawatt hours
PPA	Power Purchase Agreement
R	Rand
RE IPPPP	Renewable Energy Independent Power Producer Procurement Programme
SED	Socio-Economic Development
WEF	Wind Energy Facility

1 INTRODUCTION

This report was prepared in response to the request by Enviro-Insight CC to undertake a socio-economic assessment of the potential wake effects that the proposed Botterblom Wind Energy Facility (WEF) could exert on the six WEFs - two existing WEFs (i.e. Loeriesfontein WEF and Khobab WEF) and four WEFs that are proposed to be developed (i.e. Kokerboom 1, Kokerboom 2, Kokerboom 3 and Kokerboom 4 WEFs).

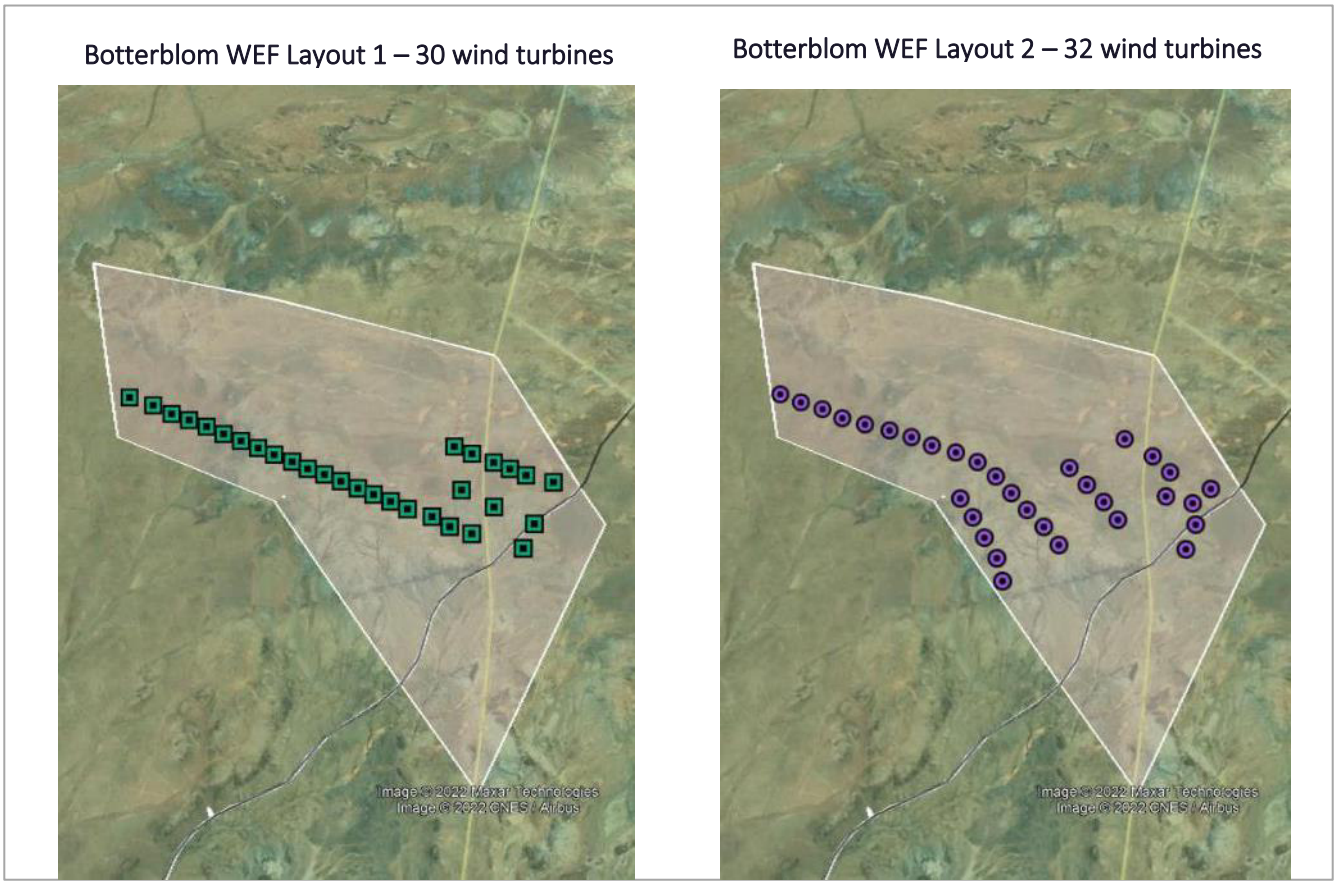
1.1 STUDY BACKGROUND AND RATIONALE

FE Botterblom (Pty) Ltd (hereafter referred to as "the project proponent") is proposing to develop the Botterblom WEF approximately 50 km North (as crow flies) of the town of Loeriesfontein in the Northern Cape Province, as illustrated on Map 1-1.



Map 1-1: Location of Botterblom WEF

Two alternative turbine layouts are currently investigated for the Botterblom WEF. As illustrated on Map 1-2, Layout 1 comprises of 30 wind turbines, while Layout 2 comprises of 32 wind turbines. With both layouts considering Nordex N163 5.7 MW wind turbine that has a rated power of 5.7 MW, Layout 1 is expected to have 171 MW of a generating capacity and Layout 2 – 182.4 MW.

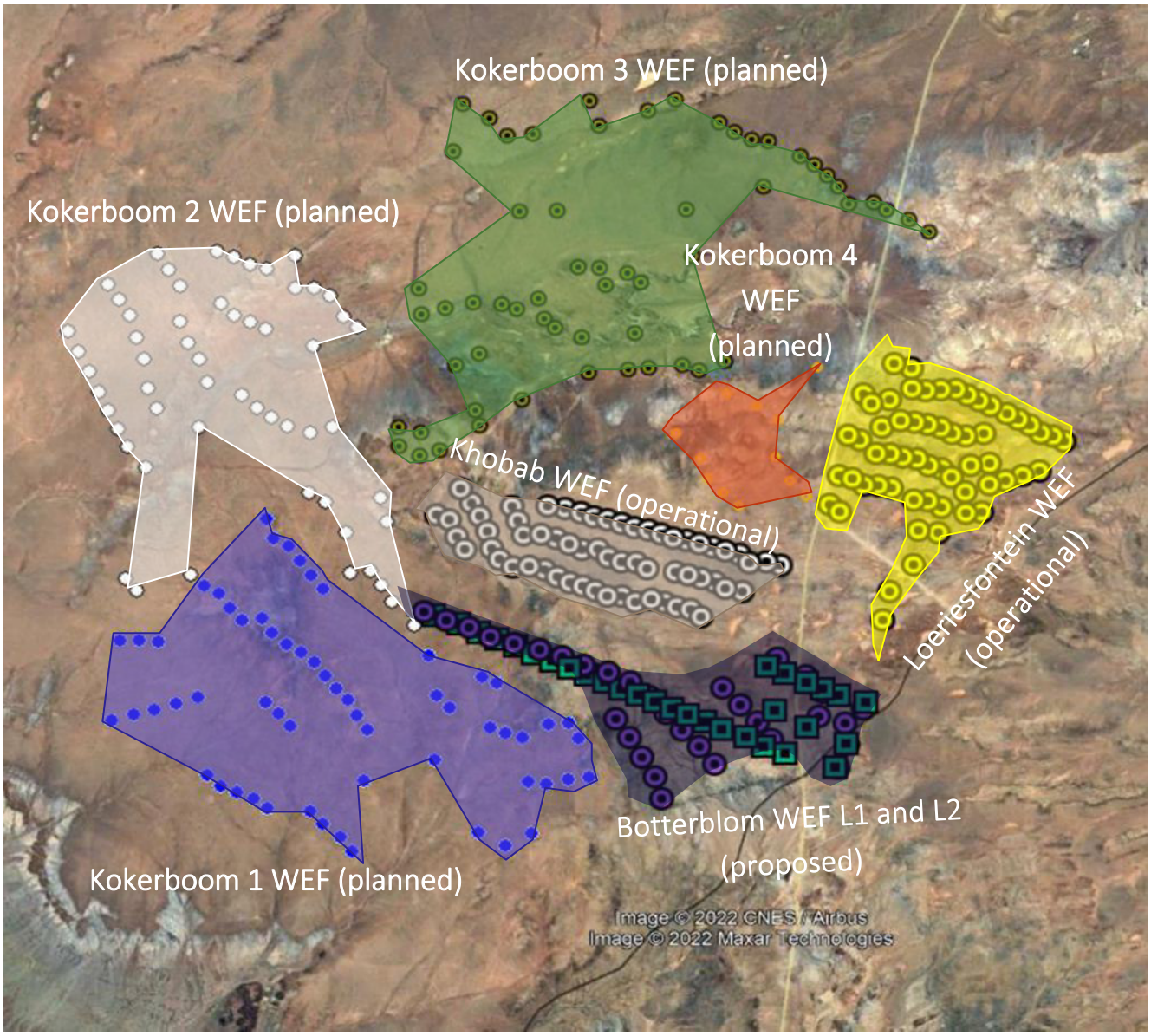


Map 1-2: Alternative layouts for Botterblom WEF

The Botterblom WEF is proposed to be located near several already existing and planned WEFs. As illustrated on Map 1-3, two already operating WEFs – Khobab and Loeriesfontein WEFs – are situated immediately North and North-East from the proposed location of the Botterblom WEF, respectively. Further North are proposed to be located two Kokerboom WEFs – Kokerboom 3 and Kokerboom 4. These facilities are currently undergoing an Environmental Impact Assessment (EIA) process and have not yet been authorised. The other two Kokerboom WEFs – Kokerboom 1 and Kokerboom 2 – that are located to the West and North-West from the proposed Botterblom WEF, respectively, have received authorisation in 2017 but not yet constructed.

Considering the proximity of the proposed Botterblom WEF to the existing and planned WEFs, the project proponent has commissioned an independent assessment of the turbine interaction losses caused by the proposed WEF on the nearby WEFs. The study was undertaken by DNV South Africa (Pty) Ltd with the associated report submitted in February 2022. It should be noted that another WEF – Dwarsrug WEF – planned for the development to the East and South-East of the proposed Botterblom WEF was excluded from this assessment due to the absence of the final wind turbine layout that was available at the time of the Wake Impact Assessment study.

With the Wake Impact Assessment Report (DNV, 2022) determining the potential negative effect on the existing and planned WEFs mentioned above, the project proponent identified the need to assess the impact thereof on the community development contributions of the potentially affected WEFs to inform the identification of suitable mitigation measures.



Map 1-3: Location of Botterblom WEF relative to the existing and planned WEFs included in the scope of this study

1.2 STUDY SCOPE

The purpose of the study is to provide an independent assessment of socio-economic impacts on community development contributions that could ensue from turbine interaction losses caused by the Botterblom WEF. The study aims to determine the opportunity cost and a cumulative socio-economic impact on the socio-economic development (SED) and enterprise development (ED) contributions of the proposed Botterblom WEF and potentially affected WEFs.

To achieve the above objective of the study, the following research questions are aimed to be responded to:

- What potential SED and ED contributions can be expected from the proposed Botterblom WEF, as well as the potentially affected existing and planned WEFs considered in this study?

- What are the opportunity costs linked to the potential change in SED and ED contributions of the potentially affected WEFs linked to the turbine interaction losses caused by the Botterblom WEF?
- What is the cumulative socio-economic impact on the local communities linked to SED and ED contributions that can be expected to be derived during the Power Purchase Agreement (PPA) periods of all WEFs considered?
- How should the potential negative socio-economic impacts be mitigated?
- What recommendations can be made going forward?

1.3 REPORT STRUCTURE

The report is structured as follows:

- Chapter 2 contains a detailed description of project alternatives and assumptions used in the analysis.
- Chapter 3 contains the results of the analysis for each alternative considered, and the cumulative effect.
- Chapter 4 provides concluding remarks, recommendations for mitigation measures and rating of the impacts.

2 CONSIDERED ALTERNATIVES AND ASSUMPTIONS

This chapter contains a detailed description of project alternatives used in the assessment and the assumptions associated with the electricity generation, applied tariff, wake effects, and SED and ED contributions by each WEF considered in the study. Information about alternatives and wake effects caused by the Botterblom WEF was sourced from the DNV study (2022). Assumptions regarding electricity generation of the existing, planned, and proposed WEFs, tariffs, and SED and ED contributions relative to the derived revenue were sourced from various public documents and the internet.

2.1 PROJECT ALTERNATIVES

The layout for the Botterblom WEF has not yet been finalised, but two alternatives are currently considered by the project proponent, as was mentioned in section 1.1. The layout does not only different in terms of the location of wind turbines but also in terms of the number of wind turbines that will be established. Since the type of wind turbine is assumed to be the same, each alternative is associated with a different nameplate capacity.

As mentioned earlier, the Botterblom WEF Layout 1 (hereafter referred to as Botterblom L1) is expected to have 30 wind turbines and reach a 171 MW nameplate capacity. The Botterblom WEF Layout 2 (Botterblom L2) is envisaged to have 32 wind turbines and comprise of a 182.4 MW capacity. These assumptions are captured in Table 2-1.

Table 2-1: Botterblom WEF's layout alternatives assumptions

Nameplate capacity	Number of turbines	Nameplate capacity of a turbine	Total nameplate capacity of WEF
Botterblom L1	30	5.7 MW	171.0 MW
Botterblom L2	32	5.7 MW	182.4 MW

(DNV, 2022)

2.2 POTENTIALLY AFFECTED WEFS' NAMEPLATE CAPACITIES

For the purpose of this study, the following assumptions with regard to the nameplate capacities of the nearby WEFs are applied:

Table 2-2: Assumption concerning targeted and known generation capacities of the nearby WEFs

Nameplate capacity	Number of turbines	Nameplate capacity of a turbine	Total generating capacity of WEF
Loeriesfontein WEF	59	2.3 MW	135.7 MW
Khobab WEF	61	2.3 MW	140.3 MW
Kokerboom 1 WEF	60	5.6 MW	336 MW
Kokerboom 2 WEF	57	5.6 MW	319.2 MW
Kokerboom 3 WEF	60	5.6 MW	336 MW
Kokerboom 4 WEF	12	5.6 MW	67.2 MW

(DNV, 2022)

The following should be noted:

- The information contained in a fact sheet available on the Loeriesfontein WEF website (MAMSA, 2022b) suggests that the wind farm comprises of 61 wind turbines with a nameplate capacity of 2.3 MW each. The actual number of wind turbines that can be identified from Google Earth is 59, though. Since the project is already operational, the actual number of wind turbines have been used in the study, which was also the data used by DNV in their specialist study (2022).
- With regard to the Khobab WEF, no discrepancies between the data used in the DNV study (2022), the number of wind turbines operating as identified from the Google Earth, and the number of wind turbines referred to in the fact sheet on the WEF's website (MAMSA, 2022a) have been noted. Thus, the assumption is that the Khobab WEF comprises of 61 turbines with 2.3 MW nameplate capacity each.
- The Kokerboom 1 WEF was authorised, as amended (DEA, 2019), to comprise of up to 60 wind turbines with a maximum of 6.5 MW nameplate capacity each. The DNV study (2022) assumed a 5.6 MW wind turbine option, suggesting that the WEF would have a total generating capacity of 336 MW.
- Considering the amendment authorised in 2019 (DEA, 2019), the Kokerboom 2 WEF will include 57 wind turbines of up to 6.5 MW nameplate capacity each. The DNV study (2022) assumed that a 5.6 MW turbine would be used, thus assuming a 319.2 MW generating capacity for the project.
- The Kokerboom 3 WEF obtained its environmental authorisation in February 2018 (Zutari, 2021a). However, the recognition of the wake effects between Kokerboom 3 and the nearby Loeriesfontein and Khobab WEFs necessitated the revision of the original layout (Zutari, 2021a). As a result, the project was split into two – Kokerboom 3 WEF and Kokerboom 4 WEF with new EIA applications being prepared for both projects (Zutari, 2021a). The EIA study for Kokerboom 3 WEF (Zutari, 2021a) assumes the project to include 60 wind turbines and a targeted generation capacity of up to 300 MW. As indicated Table 2-2, the DNV study (2022) assumed a 5.6 MW turbine used by the project; thus, the total generating capacity for the Kokerboom 3 WEF applied in this study is 336 MW.
- The draft EIA report (Zutari, 2021b) for the Kokerboom 4 WEF assumed the project to contain 12 wind turbines of up to 6.5 MW nameplate capacity and a maximum total generation capacity of 60 MW. The DNV study (2022) assumed a 5.6 MW wind turbine configuration for all Kokerboom projects, including the Kokerboom 4 WEF. With the planned number of wind turbines used in the DNV study remaining as that proposed in the EIA report, the total generating capacity for the facility applied in this study is 67.2 MW.

2.3 ELECTRICITY GENERATION ASSUMPTIONS

Electricity generation assumptions are necessary to forecast and estimate the potential revenue to be generated by each WEF and subsequent contributions that the respective projects will make towards community development through SED and ED interventions. Estimation of the potential electricity generating capacity can be done using a Capacity Factor (CF) that takes into account wind resources, wind variability, and system availability (i.e. downtime, maintenance and breakdowns) and multiplying it by the total generating capacity of a WEF.

CF data is usually not available in the public domain and when provided is given as a range. The review of the EIA reports produced for the projects did not reveal any insights into CFs that can be expected for the reviewed WEFs. However, of seven projects that are considered in this study – including the Botterblom WEF, two are already

operational. Given the proximity of WEFs included in the study, it can be assumed that the CF experienced by the Loeriesfontein and Khobab WEFs could also be applied to the other WEFs.

MAMSA (2022a; 2022b) indicated that the Loeriesfontein and Khobab WEFs can generate around 535 500 MWh and 563 500 MWh of electricity per annum, respectively, when operating at full capacity. Assuming the total generating capacity installed at these facilities (refer to Table 2-2), the resulting CFs for the Loeriesfontein WEF and the Khobab WEF are 45.0% and 45.9%, respectively. Assuming that the other WEFs in the area would be able to deliver the CF that reflects an average between Loeriesfontein and Khobab WEFs (i.e. 45.4%), the electricity generated by these facilities on an annual basis can be estimated as follows:

Table 2-3: Assumption concerning annual electricity generation

Nameplate capacity	Total generating capacity of WEF	Capacity Factor	Electricity generation per annum
Loeriesfontein WEF	135.7 MW	45.0% (derived)	535 500 MWh
Khobab WEF	140.3 MW	45.9% (derived)	563 500 MWh
Kokerboom 1 WEF	336 MW	45.4% (average for Loeriesfontein and Khobab WEFs)	1,337,536 MWh
Kokerboom 2 WEF	319.2 MW		1,270,659 MWh
Kokerboom 3 WEF	336 MW		1,337,536 MWh
Kokerboom 4 WEF	67.2 MW		267,507 MWh
Botterblom L1	171 MW		680,710 MWh
Botterblom L2	182.4 MW		726,091 MWh

(estimated using data provided by MAMSA, 2022a; 2022b)

2.4 WAKE EFFECTS AND WAKE LOSSES ASSUMPTIONS

Table 2-4 provides the assumptions regarding the envisaged wake effect to be exerted by the Botterblom WEF on the nearby WEFs depending on the layout alternative considered. It shows that given the envisaged external turbine interactions predicted by DNV (2022), the external wake losses are expected to be in the range of 0.2% to 1.8% depending on the layout alternative considered.

Table 2-4: Assumption concerning wake effects

Nameplate capacity	Botterblom L1		Botterblom L2	
	External turbine interaction effect	External wake loss	External turbine interaction effect	External wake loss
Loeriesfontein WEF	98.2%	1.8%	98.3%	1.7%
Khobab WEF	98.4%	1.6%	98.4%	1.6%
Kokerboom 1 WEF	99.2%	0.8%	99.2%	0.8%
Kokerboom 2 WEF	99.7%	0.3%	99.7%	0.3%
Kokerboom 3 WEF	99.7%	0.3%	99.7%	0.3%
Kokerboom 4 WEF	99.2%	0.8%	99.2%	0.8%

(DNV, 2022)

The following can be highlighted:

- Wake losses associated with two layout alternatives proposed for the Botterblom WEF are expected to be the same for all WEFs except for the Loeriesfontein WEF. The Botterblom L1 WEF is expected to be associated with a slightly greater external wake loss on the Loeriesfontein WEF than the Botterblom L2 WEF.
- Among the six WEFs considered for the potential external wake effect, the greatest losses will ensue for the already operational WEFs, i.e. Loeriesfontein WEF and Khobab WEF. The expected wake loss for these two WEFs is estimated between 1.6% and 1.8%, with the Loeriesfontein WEF to incur 1.7% and 1.8% wake losses depending on the layout option chosen for the Botterblom WEF and the Khobab WEF – 1.6% irrespective of the layout option chosen for the Botterblom WEF.
- Among the set of Kokerboom WEFs, the most impacted WEFs will be Kokerboom 1 WEF and Kokerboom 4 WEF. These two WEFs are expected to experience a 0.8% wake loss due to the establishment of the Botterblom WEF, irrespective of the layout alternative chosen for the Botterblom WEF. The other two Kokerboom WEFs are expected to experience the lowest wake losses among the six WEFs reviewed, i.e. 0.3%.

2.5 OPERATIONAL PERIODS ASSUMPTIONS

The potential wake losses that are to be exerted by the Botterblom WEF will be experienced during the operational periods. For the purpose of this study, only the period linked to the Power Purchase Agreement (PPA) of s project is considered. Although WEFs can be refurbished and their lifespan could be extended, the current and future commitments made with respect to SED and ED contributions are linked to PPAs, therefore, the modelling and impact assessment is also done for the period of PPA signed or to be signed by WEFs.

The Loeriesfontein WEF and Khobab WEF started operations on 8 December 2017 (MAMSA, 2022a; MAMSA, 2022b). For the ease of the assessment, their start of operations is assumed to be January 2018.

Since Kokerboom WEFs have not yet been selected under any of the bid windows released previous through the Renewable Energy Power Purchase Procurement Programme (REIPPPP), there is a great uncertainty with regard to the expected date of operation for these facilities. However, the Kokerboom 1, Kokerboom 2, and Kokerboom 3 (in the old configuration) WEFs have been part of bid submissions received by the Department of Minerals Resource and Energy (DMRE) for REIPPPP Bid Window 5 (DMRE, 2021a). With REIPPPP Bid Window 5 being oversubscribed, it is likely that many of the projects that were not chosen as preferred bidders under Bid Window 5 will apply for Bid Window 6.

Government planned “to release Bid Window 6 by no later than end of January 2022” (DMRE, 2021b). However, as of end of February 2022, such an announcement has not been made and it is unknown when Bid Window 6 will be released. For the purpose of this study, though, it is assumed that it will take place by December 2022. It is also assumed that subsequent bid windows will be released once a year.

Since the Kokerboom 1 and Kokerboom 2 WEFs have been part of the Bid Window 5 submission, it is assumed that these two projects will be submitted under Bid window 6 and will be chosen as preferred bidders as early as end of 2022. It is also assumed that it will take three years for the projects to reach an operational status (time required to reach financial closure, complete construction, and connected to the grid). This means that the Kokerboom 1 and Kokerboom 2 WEFs are assumed to start operations in January 2026.

The original Kokerboom 3 WEF has been split into the Kokerboom 3 and Kokerboom 4 WEFs, which are currently undergoing new EIA processes. Given the time required to complete these processes, the Kokerboom 3 and Kokerboom 4 projects will not be ready for participation in Bid Window 6. Assuming though that these projects receive environmental authorisations in 2022, they can be ready for participation in Bid Window 7. Assuming Bid Window 7 is released in 2023 and the two projects are successful, the Kokerboom 3 and Kokerboom 4 WEFs could become operational in January 2027.

With regard to the Botterblom WEF, which EIA processes is running slightly behind the Kokerboom 3 and Kokerboom 4 WEFs, the environmental authorisation for the project may also be received later than that obtained for the Kokerboom 3 and Kokerboom 4 WEFs. Furthermore, with the large number of WEFs already applying for a preferred status under Bid Window 5, there is a high chance that Bid Window 6 and Bid Window 7 could also be oversubscribed. This means that the Botterblom WEF could be considered only in Bid Window 8 and, therefore, come online at least one year after the start of operations of the Kokerboom 3 and Kokerboom 4 WEFs. However, in order to follow a conservative approach and assume a "worst case" scenario, for the purpose of this study, the start of the operational period for the Botterblom WEF is deemed to coincide with that of the Kokerboom 3 and Kokerboom 4 WEFs.

Given the above assumptions, the overlaps in operational periods limited to the duration of PPAs, can be illustrated as follows:

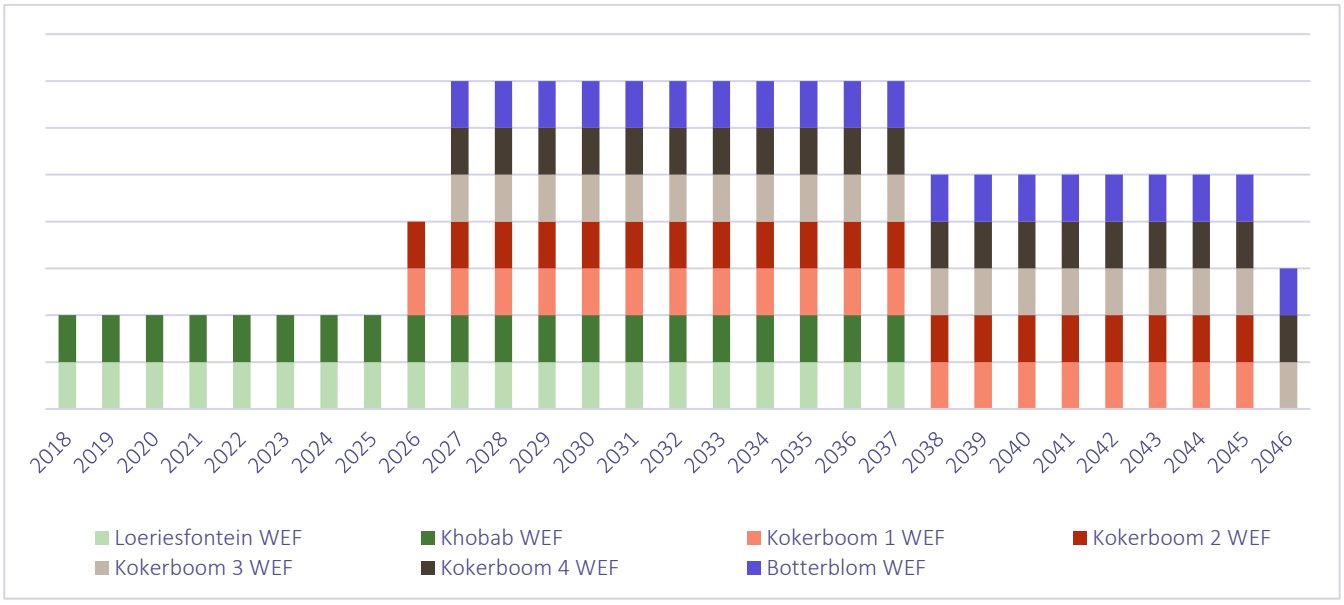


Figure 2-1: Overlaps in operational periods limited by the duration of PPAs

From the above, the potential number of years during which the wake losses caused by the proposed Botterblom WEF can be expected by each WEF under analysis will vary. As indicated in Table 2-5, the shortest period will apply to the Loeriesfontein WEF and Khobab WEF with a total of 11 years of impact, and the longest period will apply to the Kokerboom 3 and Kokerboom 4 WEFs with the impact spanning the entire 20-year PPA period.

Table 2-5: Assumption regarding operational periods

Nameplate capacity	Start of operations	PPA period (years)	Overlapping period (years)
Loeriesfontein WEF	January 2018	20	11
Khobab WEF	January 2018	20	11
Kokerboom 1 WEF	January 2026	20	19
Kokerboom 2 WEF	January 2026	20	19
Kokerboom 3 WEF	January 2027	20	20
Kokerboom 4 WEF	January 2027	20	20
Botterblom WEF	January 2027	20	20

2.6 ELECTRICITY TARIFFS ASSUMPTIONS

With two of the six WEFs that are included in the analysis already operational, the tariffs applied for these projects need to reflect the tariffs that have been reported by the DMRE at the time of the preferred bidder announcement. The DMRE (then Department of Energy) announced the following fully indexed tariffs in November 2013 for the two projects (DOE, 2013):

- Loeriesfontein WEF tariff: R759.6/MWh
- Khobab WEF tariff: R746.4/MWh

Since preferred bidders sign a PPA and prices are non-negotiable, it is assumed that the above tariffs would be valid for the entire duration of PPAs signed. However, these prices reflect a fully indexed price in 2013 and need to be adjusted to reflect constant 2021 figures. Since indexation is usually done using Consumer Price Inflation (CPI), the same is applied to estimate the 2021 tariffs for the above-mentioned two WEFs. Using Statistics SA CPI data (Statistics SA, 2022), the 2021 tariffs for the two WEFs are therefore estimated as follows:

- Loeriesfontein WEF tariff: R1 111.3/MWh
- Khobab WEF tariff: R1 091.9/MWh

None of the Kokerboom 1, 2,3, and 4 WEFs have been selected as preferred bidders yet. However, tariffs linked to bid windows have been on a decline (GreenCape 2020); therefore it is safe to assume that the tariffs assigned to future WEFs will not be higher than the tariffs approved in the last bid window.

The most recent bid window for which information is available is Bid Window 5. Fully indexed tariffs for this bid window for onshore WEFs are provided in Table 2-6. It shows that the average weighted tariff for WEFs selected as preferred projects under Bid Window 5 was R494.39/MWh. For projects located in the Northern Cape, the weighted average tariff was lower and stood at R400.26/MWh. Furthermore, the Dwarsrug WEF, which is to be developed South-East of the proposed Botterblom WEF's location, had the lowest of all WEFs tariff of R344.25/MWh. The latter clearly illustrates, among others, a significant wind resource potential available in the area under analysis. Indeed, while the CF throughout the country varies between 30% and 40, the existing Loeriesfontein and Khobab WEFs are able to achieve 45% CF.

Table 2-6: Bid Window 5 tariffs for onshore WEFs (tariffs are fully index to 2021 prices)

Wind Farm	Location	Fully indexed price (R/MWh)	Contracted capacity (MW)
Dwarsrug Wind Facility	Northern Cape	344.25	124
Sutherland Wind Facility	Northern Cape	428.27	140
Rietrug Wind Facility	Northern Cape	428.27	140
Beaufort West Wind Facility	Western Cape	427.41	140
Trakas Wind Facility	Western Cape	427.41	140
Brandvalley Wind Farm	Western Cape	496.9	140
Rietkloof Wind Farm	Western Cape	502.7	140
Waaihoek Wind Facility	KwaZuu-Natal	529.78	140
San Kraal WEF	Northern Cape, Eastern Cape	564.45	140
Phezukomoya WEF	Northern Cape, Eastern Cape	564.45	140
Coleskop WEF	Northern Cape, Eastern Cape	601.17	140
Wolf Wind Farm	Eastern Cape	617.7	84
Average - TOTAL	**-**	494.39	134
Average – Northern Cape only	**-**	400.26	134.7

(IPP office, 2021)

Given the proximity of the Dwarsrug WEF to the facilities under analysis, and given the higher than average CF that is observed in the area, the expected tariffs for the Kokerboom 1, Kokerboom 2, Kokerboom, 3, Kokerboom 4 and the Botterblom WEFs are assumed to be the same as that for the Dwarsrug WEF reported by the IPP office (2021).

2.7 REVENUE GENERATION ASSUMPTIONS

Considering the estimated annual electricity generation figures presented in Table 2-3 and applied electricity tariffs outlined in section 2.6, the assumptions regarding estimated annual revenue generated or to be generated by each WEF under analysis are provided in Table 2-7. The table also provides the total revenue estimated to be generated by each of the facility during the time when the PPAs of the Botterblom WEF and the respective potentially affected WEF overlap. It is worth noting that although the Kokerboom 1, Kokerboom 2, and Kokerboom 3 WEFs are expected to have more than two times bigger generating capacities than the already operational Loeriesfontein and Khobab WEFs, the total revenue to be derived by all of these facilities will not differ significantly. This is due to the fact that the levelised cost of electricity derived from onshore wind has dropped significantly in the past decade, leading to the tariffs dropping more than three times relative to the 2013 level.

Table 2-7: Revenue generation assumptions (2021 prices)

WEF	Annual electricity generation (MWh)	Applied tariff (R/MWh)	Annual revenue (R'm)	Overlapping PPA period		Outstanding PPA	
				Years	Revenue (R'm)	Years	Revenue (R'm)
Loeriesfontein WEF	535,354	1111.26	594.9	11	6,544	16	9,519
Khobab WEF	563,500	1091.95	615.3	11	6,768	16	9,845
Kokerboom 1 WEF	1,337,536	344.25	460.4	19	8,748	20	9,209

WEF	Annual electricity generation (MWh)	Applied tariff (R/MWh)	Annual revenue (R'm)	Overlapping PPA period		Outstanding PPA	
				Years	Revenue (R'm)	Years	Revenue (R'm)
Kokerboom 2 WEF	1,270,659	344.25	437.4	19	8,311	20	8,748
Kokerboom 3 WEF	1,337,536	344.25	460.4	20	9,209	20	9,209
Kokerboom 4 WEF	267,507	344.25	92.1	20	1,842	20	1,842
Botterblom L1	680,710	344.25	234.3	20	4,687	20	4,687
Botterblom L2	726,091	344.25	250.0	20	4,999	20	4,999

2.8 COMMUNITY DEVELOPMENT CONTRIBUTIONS ASSUMPTIONS

Information regarding the actual contributions towards SED and ED initiatives made by the existing WEFs and commitments of the other WEFs under analysis, including the Botterblom WEF, is limited. More specifically:

- The EIA report produced for the Khobab WEF and Loeriesfontein WEF (SiVEST, 2012) refers to 1.1% allocations towards SED and 0.4% allocation towards ED initiatives. The respective WEFs' websites make references to contributions but do not provide further details. Since the two projects were authorised on the basis of the EIA report produced by SiVEST (2012), it is therefore assumed that the community development (CD) contributions referred to in the report are still valid.
- While multiple EIA reports were produced for the four Kokerboom WEFs, none of these documents make any references to the SED and ED contributions to be made during the operations of the facilities. Thus, the commitments to be made by the proponent of the Kokerboom WEFs towards community development, besides the establishment of the Community Trust, are not known. Therefore, for the purpose of this study, the minimum requirements prescribed by the REIPPPP are applied. This means that it is assumed that each of the Kokerboom WEF would contribute 1.1% towards SED and 0% towards ED.
- With regard to the Botterblom WEF, the same approach as that applied to the Kokerboom WEFs will be used, i.e. with absence of the exact commitments a minimum threshold for CD contributions is applied.

Considering the above assumptions, the following table includes the annual contributions assumed to be made by the respective WEFs towards SED and ED initiatives per annum.

Table 2-8: SED and ED contribution assumptions (2021 prices)

WEF	SED		ED		Combined (SED and ED)	
	% of annual revenue	R'm - annual	% of annual revenue	R'm	% of annual revenue	R'm
Loeriesfontein WEF	1.1%	6.5	0.4%	2.4	1.5%	8.9
Khobab WEF	1.1%	6.8	0.4%	2.5	1.5%	9.2
Kokerboom 1 WEF	1.1%	5.1	0.0%	0.0	1.1%	5.1
Kokerboom 2 WEF	1.1%	4.8	0.0%	0.0	1.1%	4.8
Kokerboom 3 WEF	1.1%	5.1	0.0%	0.0	1.1%	5.1
Kokerboom 4 WEF	1.1%	1.0	0.0%	0.0	1.1%	1.0
Botterblom L1	1.1%	2.6	0.0%	0.0	1.1%	2.6
Botterblom L2	1.1%	2.7	0.0%	0.0	1.1%	2.7

3 ASSESSMENT OF THE SOCIO-ECONOMIC IMPACTS OF WAKE EFFECTS

This chapter presents the socio-economic impact assessment of external wake losses that are envisaged to be experienced by the Loeriesfontein WEF, Khobab WEF, and four Kokerboom WEFs as a result of operations of the Botterblom WEF. The impact assessment is investigated for two Botterblom WEF's layout alternatives.

3.1 ASSESSMENT OF POTENTIAL IMPACT OF WAKE LOSSES ON SED AND ED CONTRIBUTIONS

This section describes the implications of external wake losses caused by the Botterblom WEF on SED and ED contributions made by each potentially affected WEF analysed in this study.

3.1.1 Impact on Loeriesfontein WEF's community development contributions

The Loeriesfontein WEF came online in December 2017 and has already been operating for four years; therefore, out of 20 years for which PPA has been signed, WEF is left with 16 years of operations under the existing PPA. During that period, R9 518.7 million (2021 prices) of revenue is expected to be derived by the facility.

Table 3-1 indicates that the external wake losses caused by the Botterblom WEF will result in the reduced revenue derived by the Loeriesfontein WEF during 11 years when the operations of the two WEFs will overlap. This in turn will result in the reduced contributions made towards SED an ED initiatives during the same period. In the case of the Botterblom WEF Layout 1 alternative, the total CD contributions during the outstanding 16 years of the Loeriesfontein WEF's PPA period will be reduced by R1.8 million (2021 prices) and in the case of the Botterblom WEF Layout 2 – by R1.7 million (2021 prices). This is an equivalent of R110 000 and R100 000 reduced contributions per annum over the outstanding PPA period, respectively, in 2021 constant prices. Considering the average annual contribution of R8.92 million (2021 prices) to be made during the outstanding PPA period were the Botterblom WEF not developed (i.e. no-go option), this means that the wake losses will result in 1.2% community losses from the SED and ED perspective.

Table 3-1: Impact on Loeriesfontein WEF's community development contributions over the outstanding PPA (2021 prices)

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layut 2	
		Impact	Induced losses	Impact	Induced losses
Tariff (R/MWh)	1,111.3	1,111.3	-	1,111.3	-
PPA period left (from Jan 2022)	16.0	-	-	-	-
External turbine interaction effect	-	98.20%	-	98.30%	-
Wake effect period of influence	-	11	-	11	-
SED contributions	1.10%	1.10%	-	1.10%	-
ED contributions	0.40%	0.40%	-	0.40%	-
Revenues (R'm)					
Electricity production (MWh)	535,354	525,718	-9,636	526,253	-9,101
Annual revenue (R'm)	594.9	584.2	-10.7	584.8	-10.1
Total revenue over PPA period left	9,518.7	9,400.9	-117.8	9,407.4	-111.2
Total community development (CD) contribution - over PPA period (R'm)					
SED contributions (R'm)	104.7	103.4	-1.3	103.5	-1.2
ED contributions (R'm)	38.1	37.6	-0.5	37.6	-0.4

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layut 2	
		Impact	Induced losses	Impact	Induced losses
Total CD contribution (R'm)	142.8	141.0	-1.8	141.1	-1.7
Equivalent annual impact during the PPA period (R'm)					
SED contributions (R'm)	6.54	6.46	-0.08	6.47	-0.08
ED contributions (R'm)	2.38	2.35	-0.03	2.35	-0.03
Total CD contribution (R'm)	8.92	8.81	-0.11	8.82	-0.10

Worth noting is that any delays in the development of the Botterblom WEF will reduce the overlap of the two WEFs' operational periods, which in turn will lead to the lower wake losses for the Loeriesfontein WEF over its outstanding PPA period and a lower negative impact on SED and ED contributions made by the Loeriesfontein WEF. An opposite impact – increase in the negative impact on SED and ED contributions – will be experienced if the Botterblom WEF became operational earlier than January 2027.

3.1.2 Impact on Khobab WEF's community development contributions

The Khobab WEF, similar to the Loeriesfontein WEF, is left with 16 years of operations under the existing PPA. Given the tariffs indexed to 2021 figures, the WEF is expected to derive R9 845.0 million of revenue during that time, thus enabling a contribution of R147.7 million (2021 prices) towards CD.

The operations of the Botterblom WEF will have a negative effect on the revenue derived by the Khobab WEF during the 11 years when the projects' PPA period are assumed to overlap. As indicated in Table 3-2, the reduced revenue derived by the Khobab WEF due to the external wake losses experienced will lead to the reduction in SED and ED contributions to the tune of R1.6 million (2021 prices), irrespective of the layout alternative chosen for the Botterblom WEF. This equates to the reduced annual contributions towards CD of R100 000 per annum (2021 prices) reflecting an annual average decline by 1.1% relative to the no-go scenario (i.e. Botterblom WEF not developed).

Table 3-2: Impact on Khobab WEF's community development contributions (2021 prices)

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layout 2	
		Impact	Induced losses	Impact	Induced losses
Tariff (R/MWh)	1,091.9	1,091.9	-	1,091.9	-
PPA period left (from Jan 2022)	16.0	-	-	-	-
External turbine interaction effect	-	98.40%	-	98.40%	-
Wake effect period of influence	-	11	-	11	-
SED contributions	1.10%	1.10%	-	1.10%	-
ED contributions	0.40%	0.40%	-	0.40%	-
Revenues (R'm)					
Electricity production (MWh)	563,500	554,484	-9,016	554,484	-9,016
Annual revenue (R'm)	615.3	605.5	-9.8	605.5	-9.8
Total revenue over PPA period left	9,845.0	9,736.7	-108.3	9,736.7	-108.3
Total community development (CD) contribution - over PPA period (R'm)					
SED contributions (R'm)	108.3	107.1	-1.2	107.1	-1.2
ED contributions (R'm)	39.4	38.9	-0.4	38.9	-0.4

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layout 2	
		Impact	Induced losses	Impact	Induced losses
Total CD contribution (R'm)	147.7	146.1	-1.6	146.1	-1.6
Equivalent annual impact during the PPA period (R'm)					
SED contributions (R'm)	6.77	6.69	-0.07	6.69	-0.07
ED contributions (R'm)	2.46	2.43	-0.03	2.43	-0.03
Total CD contribution (R'm)	9.23	9.13	-0.10	9.13	-0.10

Given the already operational status of the Khobab WEF, the impact on SED and ED contributions caused by the Botterblom WEF is sensitive to the number of years when the operations of the two WEFs overlap. Any delays in bringing the Botterblom WEF online relative to the assumed January 2027 date will lead to the lower negative impact on the Khobab WEF's CD contributions caused by the former, while earlier development of the Botterblom WEF will cause an opposite effect on CD contributions made by the Khobab WEF.

3.1.3 Impact on Kokerboom 1 WEF's community development contributions

The Kokerboom 1 WEF is assumed to come online one year before the Botterblom WEF reaches an operational status. This means that the effects of the Botterblom WEF on the revenue derived by the Kokerboom 1 WEF and subsequently its contribution towards CD will be experienced during 19 years of the former's PPA period.

As indicated in Table 3-3, over the entire PPA period, the Kokerboom 1 WEF is expected to derive R9 208.9 million of revenue in 2021 prices, of which R101.3 million or 1.1% is expected to be directed towards CD. If the Botterblom WEF were developed and came online one year after the start of operations of the Kokerboom 1 WEF, the external interaction of turbines, irrespective of the layout alternative chosen for the Botterblom WEF, would reduce the revenue generation potential of the Kokerboom 1 WEF by R70 million (2021 prices) over the entire period. This means that the CD contributions made by the Kokerboom 1 WEF would be reduced by R0.8 million (2021 prices) over its entire PPA period, which equates to an average annual loss of R40 000 (2021 prices) for the communities.

Table 3-3: Impact on Kokerboom 1 WEF's community development contributions (2021 prices)

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layout 2	
		Impact	Induced losses	Impact	Induced losses
Tariff (R/MWh)	344.3	344.3	-	344.3	-
PPA period left (from Jan 2022)	20.0	-	-	-	-
External turbine interaction effect	-	99.20%	-	99.20%	-
Wake effect period of influence	-	19	-	19	-
SED contributions	1.10%	1.10%	-	1.10%	-
ED contributions	0.00%	0.00%	-	0.00%	-
Revenues (R'm)					
Electricity production (MWh)	1,337,536	1,326,835	-10,700	1,326,835	-10,700
Annual revenue (R'm)	460.4	456.8	-3.7	456.8	-3.7
Total revenue over PPA period left	9,208.9	9,138.9	-70.0	9,138.9	-70.0
Total community development (CD) contribution - over PPA period (R'm)					
SED contributions (R'm)	101.3	100.5	-0.8	100.5	-0.8
ED contributions (R'm)	0.0	0.0	0.0	0.0	0.0

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layout 2	
		Impact	Induced losses	Impact	Induced losses
Total CD contribution (R'm)	101.3	100.5	-0.8	100.5	-0.8
Equivalent annual impact during the PPA period overlap (R'm)					
SED contributions (R'm)	5.06	5.03	-0.04	5.03	-0.04
ED contributions (R'm)	-	-	0.00	-	0.00
Total CD contribution (R'm)	5.06	5.03	-0.04	5.03	-0.04

Any changes in the overlap of PPA periods between the Kokerboom 1 WEF and the Botterblom WEF will influence the value of CD contributions made by the former – the greater the overlap the bigger the negative effect and vice versa.

3.1.4 Impact on Kokerboom 2 WEF's community development contributions

The Kokerboom 2 WEF is assumed to derive R8 748.5 million (2021 prices) of revenue over its 20-year PPA period, thus enabling a R96.2 million (2021 prices) contribution towards the development of the community over the same period. As indicated in Table 3-4, the wake losses that are envisaged to ensue due to the external interaction caused by the Botterblom WEF's wind turbines will reduce the revenue generation potential by R24.9 million (2021 prices), irrespective of the layout alternative chosen. As a result, the contribution towards CD is expected to drop to R96.0 million (2021) over the PPA period suggesting a R300 000 loss in 2021 prices. In annual terms, this equates to a R10 000 reduction in CD contributions made by the Kokerboom 2 WEF.

Table 3-4: Impact on Kokerboom 2 WEF's community development contributions (2021 prices)

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layout 2	
		Impact	Induced losses	Impact	Induced losses
Tariff (R/MWh)	344.3	344.3	-	344.3	-
PPA period left (from Jan 2022)	20.0	-	-	-	-
External turbine interaction effect	-	99.70%	-	99.70%	-
Wake effect period of influence	-	19	-	19	-
SED contributions	1.10%	1.10%	-	1.10%	-
ED contributions	0.00%	0.00%	-	0.00%	-
Revenues (R'm)					
Electricity production (MWh)	1,270,659	1,266,847	-3,812	1,266,847	-3,812
Annual revenue (R'm)	437.4	436.1	-1.3	436.1	-1.3
Total revenue over PPA period left	8,748.5	8,723.6	-24.9	8,723.6	-24.9
Total community development (CD) contribution - over PPA period (R'm)					
SED contributions (R'm)	96.2	96.0	-0.3	96.0	-0.3
ED contributions (R'm)	0.0	0.0	0.0	0.0	0.0
Total CD contribution (R'm)	96.2	96.0	-0.3	96.0	-0.3
Equivalent annual impact during the PPA period overlap (R'm)					
SED contributions (R'm)	4.81	4.80	-0.01	4.80	-0.01
ED contributions (R'm)	-	-	0.00	-	0.00
Total CD contribution (R'm)	4.81	4.80	-0.01	4.80	-0.01

3.1.5 Impact on Kokerboom 3 WEF's community development contributions

The Kokerboom 3 WEF is assumed to derive R9 208.9 million (2021 prices) of revenue during its 20-year PPA period. Assuming a 1.1% contribution towards CD to be pledged by the facility, a total of R101.0 million (2021) could be directed towards CD during the same period, which equates to R5.06 million (2021 prices) per annum.

Since it was assumed that the Kokerboom 3 WEF and the Botterblom WEF will come online at the same time, the wake losses experienced by the former and caused by the latter will take place over the entire 20-year PPA periods. However, due to a small wake effect that is expected to be exerted by the Botterblom WEF on the Kokerboom 3 WEF, relatively to the other WEFs in the area, the potential losses in revenue and subsequent reduction in CD contributions will be relatively small. As indicated in Table 3-5, the CD contributions are expected to be reduced by R300 000 (2021 prices) over the entire 20-year period, which equates to R20 000 (2021 prices) reduction in annual contributions towards CD. Worth noting is that any changes in the periods of overlap between the Kokerboom 3 WEF and the Botterblom WEF will lead to lower negative effects on revenue and, as a result, a lower impact on CD contributions made by the Kokerboom 3 WEF.

Table 3-5: Impact on Kokerboom 3 WEF's community development contributions (2021 prices)

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layout 2	
		Impact	Induced losses	Impact	Induced losses
Tariff (R/MWh)	344.3	344.3	-	344.3	-
PPA period left (from Jan 2022)	20.0	-	-	-	-
External turbine interaction effect	-	99.70%	-	99.70%	-
Wake effect period of influence	-	20	-	20	-
SED contributions	1.10%	1.10%	-	1.10%	-
ED contributions	0.00%	0.00%	-	0.00%	-
Revenues (R'm)					
Electricity production (MWh)	1,337,536	1,333,523	-4,013	1,333,523	-4,013
Annual revenue (R'm)	460.4	459.1	-1.4	459.1	-1.4
Total revenue over PPA period left	9,208.9	9,181.3	-27.6	9,181.3	-27.6
Total community development (CD) contribution - over PPA period (R'm)					
SED contributions (R'm)	101.3	101.0	-0.3	101.0	-0.3
ED contributions (R'm)	0.0	0.0	0.0	0.0	0.0
Total CD contribution (R'm)	101.3	101.0	-0.3	101.0	-0.3
Equivalent annual impact during the PPA period overlap (R'm)					
SED contributions (R'm)	5.06	5.05	-0.02	5.05	-0.02
ED contributions (R'm)	-	-	0.00	-	0.00
Total CD contribution (R'm)	5.06	5.05	-0.02	5.05	-0.02

3.1.6 Impact on Kokerboom 4 WEF's community development contributions

The Kokerboom 4 WEF is the smallest of all WEFs analysed in this study. With a planned generating capacity of 67.2 MW, the WEF is assumed to derive R1 841. 8 million (2021 prices) of revenue during its 20-year PPA period. Assuming a 1.1% contribution towards CD, R20.3 million (2021 prices) will be contributed towards CD over its PPA period.

The operations of the Botterblom WEF, which is assumed to coincide with the operations of the Kokerboom 4 WEF over the 20-year PPA periods of both, will cause a reduction in electricity production by the latter. As indicated in Table 3-6, the reduced production will lead to the loss of revenue to the tune of R14.7 million (2021 prices) over the 20 year-period. With an assumed 1.1% contribution towards CD, the direct investments into communities (outside The community Trust that may be established) will be reduced by R200 000 (2021 prices) over the PPA period or by R10 000 (2021 prices) per annum.

Table 3-6: Impact on Kokerboom 4 WEF's community development contributions (2021 prices)

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layout 2	
		Impact	Induced losses	Impact	Induced losses
Tariff (R/MWh)	344.3	344.3	-	344.3	-
PPA period left (from Jan 2022)	20.0	-	-	-	-
External turbine interaction effect	-	99.20%	-	99.20%	-
Wake effect period of influence	-	20	-	20	-
SED contributions	1.10%	1.10%	-	1.10%	-
ED contributions	0.00%	0.00%	-	0.00%	-
Revenues (R'm)					
Electricity production (MWh)	267,507	265,367	-2,140	265,367	-2,140
Annual revenue (R'm)	92.1	91.4	-0.7	91.4	-0.7
Total revenue over PPA period left	1,841.8	1,827.1	-14.7	1,827.1	-14.7
Total community development (CD) contribution - over PPA period (R'm)					
SED contributions (R'm)	20.3	20.1	-0.2	20.1	-0.2
ED contributions (R'm)	0.0	0.0	0.0	0.0	0.0
Total CD contribution (R'm)	20.3	20.1	-0.2	20.1	-0.2
Equivalent annual impact during the PPA period overlap (R'm)					
SED contributions (R'm)	1.01	1.00	-0.01	1.00	-0.01
ED contributions (R'm)	-	-	0.00	-	0.00
Total CD contribution (R'm)	1.01	1.00	-0.01	1.00	-0.01

3.2 OPPORTUNITY COST

The Botterblom WEF, depending on the layout alternative chosen is expected to generate between 680 710 MWh and 726 091 MWh of electricity per annum once reaching a full operational capacity. Assuming a tariff of R344.25/MWh, this translates into R4 687 million (2021 prices) of revenue for the Botterblom L1 WEF and R4 999 million (2021 prices) for the Botterblom L2 WEF.

With an assumed 1.1% contribution towards CD by the Botterblom WEF, the project has the potential to invest between R51.6 million and R55.0 million (2021 prices) into socio-economic development of the community depending on the layout option chosen. This translates into R2.6 million and R2.7 million (2021 prices) that can be made available for CD, were the Botterblom WEF approved and constructed. These figures reflect the opportunity costs for the community which will be experienced were the Botterblom WEF not come in fruition.

3.3 CUMULATIVE IMPACT ASSESSMENT AND OPPORTUNITY COST ANALYSIS

While the previous sections providing the assessment of the potential losses and opportunity costs linked to each individual WEF, this section presents the cumulative results. The cumulative impact is assessed for a scenario when all assumptions presented earlier are realised and all seven WEFs come online or operate.

As illustrated in Table 3-7, the no-go scenario, which assumes the Botterblom WEF is not developed, is associated with R609.5 million of potential contribution towards CD in the area by six WEFs. This translates into an average R24.4 million (2021 prices) spent on an annual basis by these WEFs.

The development of the Botterblom WEF will result in R4.9 million (2021) in the case of layout option 1 and R4.8 million (2021 prices) in the case of layout option 2 reduction in the total CD contributions made by the six WEFs over their PPA periods. These losses reflect a 0.8% decline in CD contribution that could be made by these six WEFs were the Botterblom WEF not developed.

At the same time, however, the development of the Botterblom WEF would create another source of CD contributions to the community, which is expected to range between R51.6 million (2021) and R55.0 million (2021 prices) over the 20-year PPA period, depending on the layout chosen. These potential contributions are more than ten times greater than the losses that could be caused by the Botterblom WEF as a result of external wake effect. Thus, the net effect from the community perspective is positive and equate to R46.7 million (2021 prices) greater CD investments if the Botterblom L1 WEF is developed and R50.2 million (2021 prices) greater CD investments in the Botterblom WEF developed using layout option 2.

Table 3-7: Cumulative impact on community development contributions (2021 prices)

Indicator	Impact without Botterblom WEF	Impact with Botterblom WEF			
		Layout 1		Layout 2	
		Impact	Induced losses/gains	Impact	Induced losses/gains
Total community development contributions during PPA period overlap (R'm)					
Loeriesfontein WEF	142.8	141.0	-1.8	141.1	-1.7
Khobab WEF	147.7	146.1	-1.6	146.1	-1.6
Kokerboom 1 WEF	101.3	100.5	-0.8	100.5	-0.8
Kokerboom 2 WEF	96.2	96.0	-0.3	96.0	-0.3
Kokerboom 3 WEF	101.3	101.0	-0.3	101.0	-0.3
Kokerboom 4 WEF	20.3	20.1	-0.2	20.1	-0.2
Botterblom WEF	-	51.6	51.6	55.0	55.0
Annual average total community development contributions during PPA period overlap (R'm)					
Loeriesfontein WEF	8.9	8.8	-0.1	8.8	-0.1
Khobab WEF	9.2	9.1	-0.1	9.1	-0.1
Kokerboom 1 WEF	5.1	5.0	0.0	5.0	0.0
Kokerboom 2 WEF	4.8	4.8	0.0	4.8	0.0
Kokerboom 3 WEF	5.1	5.0	0.0	5.0	0.0
Kokerboom 4 WEF	1.0	1.0	0.0	1.0	0.0
Botterblom WEF	-	2.6	2.6	2.7	2.7
Cumulative impact (R'm)					
Total contributions during PPA periods	609.5	656.2	46.7	659.7	50.2
Annual contributions between 2022 and 2046	24.4	26.2	1.9	26.4	2.0

4 CONCLUDING REMARKS AND RECOMMENDATIONS

This report was prepared in response to the request made by Enviro-Insight on behalf of FE Botterblom (PTY) Ltd to provide an independent assessment of the socio-economic implications of the potential wake losses that could be caused by the Botterblom WEF on six WEFs. The assessment aimed to determine both the individual and cumulative effects of the Botterblom WEF on the community development contributions made by the WEFs.

Community development contributions made by WEFs, which are selected as preferred bidders though the REIPPPP, are linked to the revenue derived by the same facilities. With community development contributions set as a percent of annual revenue, this means that any changes in the revenue of a WEF would result in the changes of the contribution made by the same facility for the development of the community.

The study conducted by DNV (DNV, 2022) revealed that external turbine interactions caused by the Botterblom WEF will result in wake losses, which translates into reduced amount of electricity that potentially affected WEFs could generate. This results in the losses of annual revenues and, by extrapolation, leads to the reduced community development contributions that the WEFs can make.

The results of the study show that the Botterblom WEF could cause between R4.9 million (2021 prices) and R4.8 million (2021 prices) of losses for the community during the PPA periods of six WEFs, depending on the layout option chosen. The majority of these losses will ensue from the impact of the Botterblom WEF on the already operating Loeriesfontein WEF (R1.8 million for Botterblom L1 WEF to R1.7 million for Botterblom L2 WEF over outstanding PPA period) and Khobab WEF (R1.6 million over outstanding PPA period, irrespective of the layout option). Among the Kokerboom WEFs, the largest negative impact on CD contributions made by these facilities will fall onto the Kokerboom 1 WEF (R0.8 millon over 20-year PPA period, irrespective of the layout option), while the smallest negative impact will be on the Kokerboom 4 WEF (R0.2 millon over 20-year PPA period, irrespective of the layout option).

The above-mentioned negative effect on the other WEFs contributions towards community development in the area is expected to be offset by the contributions made by the Botterblom WEF itself. With the proposed WEF having the potential to contribution R51.6 million to R55.0 million (2021 prices) towards community development of its 20-year PPA period, the net effect on the community will be positive. Overall, depending on the layout option chosen, the development of the Botterblom WEF will increase the community development contributions by R46.7 million to R50.2 million (2021 prices) over the PPA periods of considered WEFs.

The above clearly illustrates that, from the community development potential perspective, the opportunity costs of not developing the Botterblom WEF justify the establishment of the facility. However, it is important to acknowledge that the facility will have a negative impact on revenue generated by each of the potentially affected WEF, which could influence their ability to meet their financial commitments. To avoid this, it is recommended that the project proponent enters into the compensation agreements with the owners of the potentially affected WEFs. This would render the optimal benefits for the communities and ensure sustainability of the individual WEFs.

The assessment of impacts is provided in Table 4-1 . The rating of impacts is done following the schedule outlined in Annexure A.

Table 4-1: Impact assessment rating

Indicator	Impact on CD by Loeriesfontein WEF (L1 and L2)	Impact on CD by Khobab WEF (L1 and L2)	Impact on CD by Kokerboom 1 WEF (L1 and L2)	Impact on CD by Kokerboom 2 WEF (L1 and L2)	Impact on CD by Kokerboom 3 WEF (L1 and L2)	Impact on CD by Kokerboom 4 WEF (L1 and L2)	Impact on CD by Botterblom WEF (L1 and L2)	Cumulative impact on CD (L1 and L2)
Nature of impact	Change in the contribution towards CD due to the wake losses caused by the Botterblom WEF	Change in the contribution towards CD due to the wake losses caused by the Botterblom WEF	Change in the contribution towards CD due to the wake losses caused by the Botterblom WEF	Change in the contribution towards CD due to the wake losses caused by the Botterblom WEF	Change in the contribution towards CD due to the wake losses caused by the Botterblom WEF	Change in the contribution towards CD due to the wake losses caused by the Botterblom WEF	Change in the contribution towards CD due to contributions made by the Botterblom WEF	Change in the contribution towards CD due to the wake losses caused by the Botterblom WEF and contributions made by the Botterblom WEF
Status	Negative	Negative	Negative	Negative	Negative	Negative	Positive	Positive
Impact before mitigations								
Spatial scale	Regional	Regional	Regional	Regional	Regional	Regional	Regional	Regional
Temporal scale	Long-term (occurs during the overlaps in projects' PPA periods that is less than 15 years)	Long-term (occurs during the overlaps in projects' PPA periods that is less than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)
Probability	Probable	Probable	Probable	Probable	Probable	Probable	Highly Probable	Highly Probable

Indicator	Impact on CD by Loeriesfontein WEF (L1 and L2)	Impact on CD by Khobab WEF (L1 and L2)	Impact on CD by Kokerboom 1 WEF (L1 and L2)	Impact on CD by Kokerboom 2 WEF (L1 and L2)	Impact on CD by Kokerboom 3 WEF (L1 and L2)	Impact on CD by Kokerboom 4 WEF (L1 and L2)	Impact on CD by Botterblom WEF (L1 and L2)	Cumulative impact on CD (L1 and L2)
Severity	High (regional and/or long-term)	High (regional and/or long-term)	High (regional and/or long-term)	High (regional and/or long-term)	High (regional and/or long-term)	High (regional and/or long-term)	High (regional and/or long-term)	High (regional and/or long-term)
Significance	High	High	High	High	High	High	High	High
Impact after mitigations								
Mitigation / enhancement	Sign a compensation agreement (mitigation)	Sign a compensation agreement (mitigation)	Sign a compensation agreement (mitigation)	Sign a compensation agreement (mitigation)	Sign a compensation agreement (mitigation)	Sign a compensation agreement (mitigation)	None	Sign compensation agreements with affected WEFs (mitigation)
Spatial scale	Regional	Regional	Regional	Regional	Regional	Regional	Regional	Regional
Temporal scale	Long-term (occurs during the overlaps in projects' PPA periods that is less than 15 years)	Long-term (occurs during the overlaps in projects' PPA periods that is less than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)	Permanent (occurs during the overlaps in projects' PPA periods that is more than 15 years)
Probability	Highly improbable	Highly improbable	Highly improbable	Highly improbable	Highly improbable	Highly improbable	Highly Probable	Highly Probable
Severity	Very low (negligible or very low)	Very low (negligible or very low)	Very low (negligible or very low)	Very low (negligible or very low)	Very low (negligible or very low)	Very low (negligible or very low)	High (regional and/or long-term)	High (regional and/or long-term)
Significance	Low	Low	Low	Low	Low	Low	High	High

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ANNEXURE A: IMPACT RATING METHODOLOGY

Nature of impact

Rating	Description	Quantitative Rating
Positive	A benefit to the receiving environment (positive impact)	+
Neutral	No determined cost or benefit to the receiving environment	N
Negative	At cost to the receiving environment (negative impact)	-

Spatial scale

Rating	Description	Quantitative Rating
Very Low	**Site Specific** – impacts confined within the project site boundary	1
Low	**Proximal** – impacts extend to within 1 km of the project site boundary	2
Medium	**Local** – impacts extend beyond to within 5 km of the project site boundary	3
High	**Regional** – impacts extend beyond the site boundary and have a widespread effect - i.e. > 5 km from project site boundary	4
Very High	**Global** – impacts extend beyond the site boundary and have a national or global effect	5

Temporal scale

Rating	Description	Quantitative Rating
Very Low	**Project duration** – impacts expected only for the duration of the project or not greater than 1 year	1
Low	**Short term** – impacts expected on a duration timescale of 1 to 2 years	2
Medium	**Medium term** – impacts expected on a duration timescale of 2-5 years	3
High	**Long term** – impacts expected on a duration timescale of 5-15 years	4
Very High	**Permanent** – impacts expected on a duration timescale exceeding 15 years	5

Probability scale

Rating	Description	Quantitative Rating
Highly Improbable	Likelihood of the impact arising is estimated to be negligible; <5%.	1
Improbable	Likelihood of the impact arising is estimated to be 5-35%.	2
Possible	Likelihood of the impact arising is estimated to be 35-65%	3
Probable	Likelihood of the impact arising is estimated to be 65-95%.	4
Highly Probable	Likelihood of the impact arising is estimated to be > 95%.	5

Severity scale

Rating	Description	Quantitative Rating
Very Low	Negligible – zero or very low impact	1
Low	Site specific and short term impacts	2
Medium	Local scale and / or short term impacts	3
High	Regional and / or long term impacts	4
Very High	Global scale and / or permanent environmental change	5

Significance

Rating	Description		Quantitative Rating
Low	P × S = 1-3	(low impact significance)	L
Low/Medium	P × S = 4-5	(low/medium impact significance)	LM
Medium	P × S = 6-9	(medium impact significance)	M
Medium/High	P × S = 10-12	(medium/high impact significance)	MH
High	P × S = 13-25	(High impact significance)	H

Probability (P)	Severity (S)				
	1	2	3	4	5
1	L	L	L	LM	LM
2	L	LM	M	M	MH
3	L	M	M	MH	H
4	LM	M	MH	H	H
5	LM	MH	H	H	H