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DOCUMENT NUMBER	ISSUE	SYSTEM
WP 8638/22	0.6	De Aar 2 South WEF

SUBJECT

RFI Assessment of the Proposed WEF applicable to: De Aar 2 South WEF

KEYWORDS

electrical equipment, electrical infrastructure, EMI, RFI, OHL, WEF

DISTRIBUTION

Mulilo

SUMMARY

The De Aar 2 South WEF project, located on the Eastern plateau (South) near De Aar in the Northern Cape province, requires an RFI statement for the amendment application of the environmental authorisation. The purpose of this document is to report on the possible Radio Frequency Interference (RFI) from the Wind Energy Facilities (WEF) to the surrounding area, to assess whether any mitigation will be required to the facility if it is to be constructed.

For this project, the DFFE Screening Report indicated three high and one medium sensitivity area. The medium sensitivity area will be incorporated in the high sensitivity evaluation. The high sensitivity areas are due to:

- A telecommunications facility located 1km away from the proposed WEF location.
- A weather radar installation located between 18 and 30km away from the proposed WEF location.
- A weather radar installation located between 30 and 60km away from the proposed WEF location.

Literature study revealed that there will be no interference from the WEF to the surrounding high and medium RFI sensitive areas. This statement is only valid when assuming that the WEF electrical/electronic equipment comply to CISPR 11 class A specifications, as a technology partner has not yet been selected to provide actual RFI data.

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1. DEFINITIONS AND KEYWORDS

AMA	Astronomy Management Authority
Electrical equipment	Any electrical machinery, electrical systems, appliances, or devices, including any wireless data communication used for the operation of these facilities, used for construction, distribution and transmission power systems, exploration, farming, household, manufacturing, maintenance, or mining purposes
Electrical infrastructure	Any infrastructure or facility, including any wireless data communication used for the operation of the electrical infrastructure, to be used in any way for electricity generation, electricity distribution, electricity transmission, or for a distribution or transmission power system, and electrical facilities and equipment used for these applications
EMI	Electromagnetic Interference
OHL	Over Head Line
RFI	Radio Frequency Interference
WEF	Wind Energy Facility

Table 1: Definitions

2. BACKGROUND

The De Aar 2 South WEF project, located on the Eastern plateau (South) near De Aar in the Northern Cape province, requires an RFI statement for the amendment application of the environmental authorisation. The RFI that a new Wind Energy Facility (WEF) will have on existing electrical/electronic equipment must be evaluated.

RFI from a WEF is generally emitted from the wind turbine hubs located at the top of the mast. The effects of the WEF wind turbine hubs will be the focus of this report. RFI and electromagnetic interference (EMI) can influence sensitive facilities such as airports, RF high sites, railway line control equipment, cell phone towers, Weather Radar Installations, EMI sensitive equipment in the area, etc. If a WEF influences existing infrastructure, EMI mitigation will have to be implemented.

For this project, the DFFE Screening Report indicated three high and one medium sensitivity area. The medium sensitivity area will be incorporated in the high sensitivity evaluation. The high sensitivity areas are due to:

- A telecommunications facility located 1km away from the proposed WEF location.
- A weather radar installation located between 18 and 30km away from the proposed WEF location.
- A weather radar installation located between 30 and 60km away from the proposed WEF location.

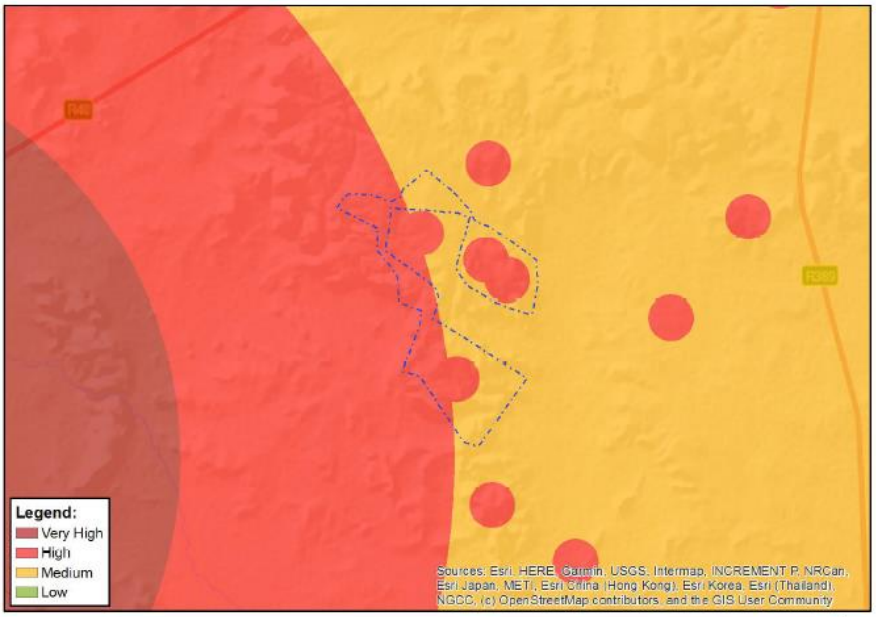
Mitigation or sufficient clearance distances, between the radio frequency (RF) source (De Aar 2 South WEF) and any RFI sensitive infrastructure (victim), are required to avoid potential degradation of the Weather Radar installation or the telecommunication facility.

The Weather Radar Installation is approximately 30km away from the proposed WEF. The closest telecommunications facility is 22.3km away from the proposed WEF. A Telecommunications facility closer than 1km could not be identified as stated in the DFFE report. There is a possibility that the proposed WEF will interfere with existing electrical/electronic equipment or electrical/electronic infrastructure, thus the effects of the WEF must be investigated.

Non-correlated noise sources such as PV facility inverters or WEF electrical/electronic equipment in close proximity could increase the level of cumulative unintentional radiated emissions at the source as seen by the victim. Refer to section 9 for further details.

Figure 1 below, contains the RFI sensitivity results according to the DFFE screening report.

MAP OF RELATIVE RFI (WIND) THEME SENSITIVITY



Sensitivity	Feature(s)
High	Low sensitivity for telecommunications;None;Between 18 and 30 km from a Weather Radar installation and within the radar's line of sight
High	Within 1 km of a telecommunication facility;None;Between 18 and 30 km from a Weather Radar installation and within the radar's line of sight
High	Within 1 km of a telecommunication facility;None;Between 30 and 60 km from a Weather Radar installation and within the radar's line of sight
Medium	Low sensitivity for telecommunications;None;Between 30 and 60 km from a Weather Radar installation and within the radar's line of sight

Figure 1 - DFFE Screening Report RFI Results

3. AIM

The aim of this document is to provide a statement with motivation regarding the RFI from the WEF Wind Turbines in the RFI sensitive areas identified by the DFFE screening report. An approximate sphere of RFI from the WEF will be noted and discussed.

As the project is still in early planning stage, no Technology partner has been selected yet. It is therefore assumed that the inverters and switching station equipment to be used will comply to CISPR 11 Class A [7]. Receiver sensitivities, inside the indicated sensitivity areas, are assumed, and listed in Table 3.

4. LOCATION

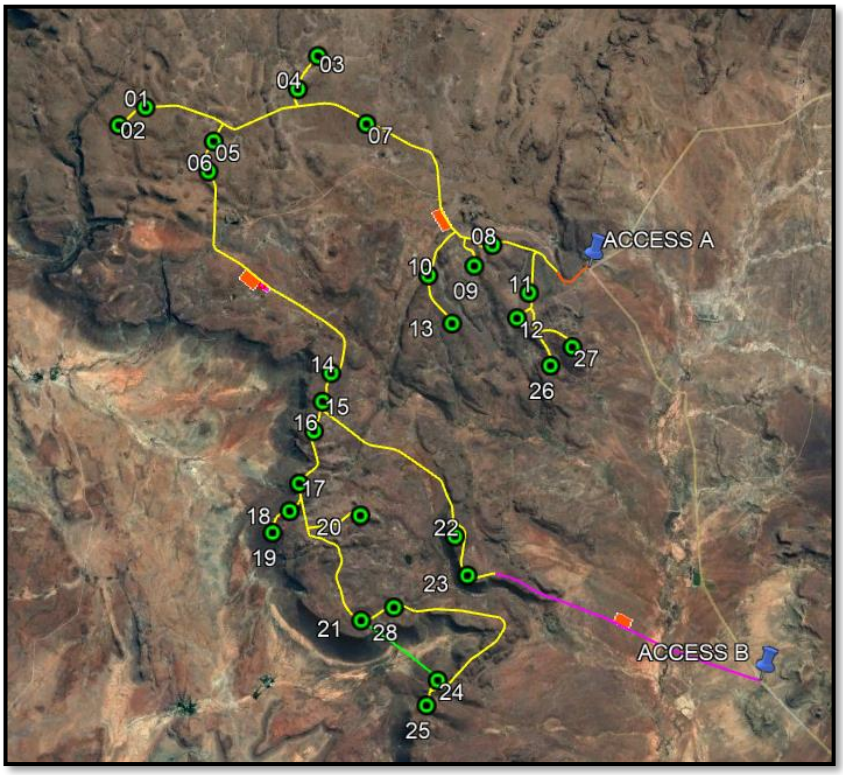


Figure 2 - Entire Proposed WEF site

Figure 3 above represents the entire proposed WEF facility site. There are 28 visible wind turbine locations, of which only 26 will be constructed.

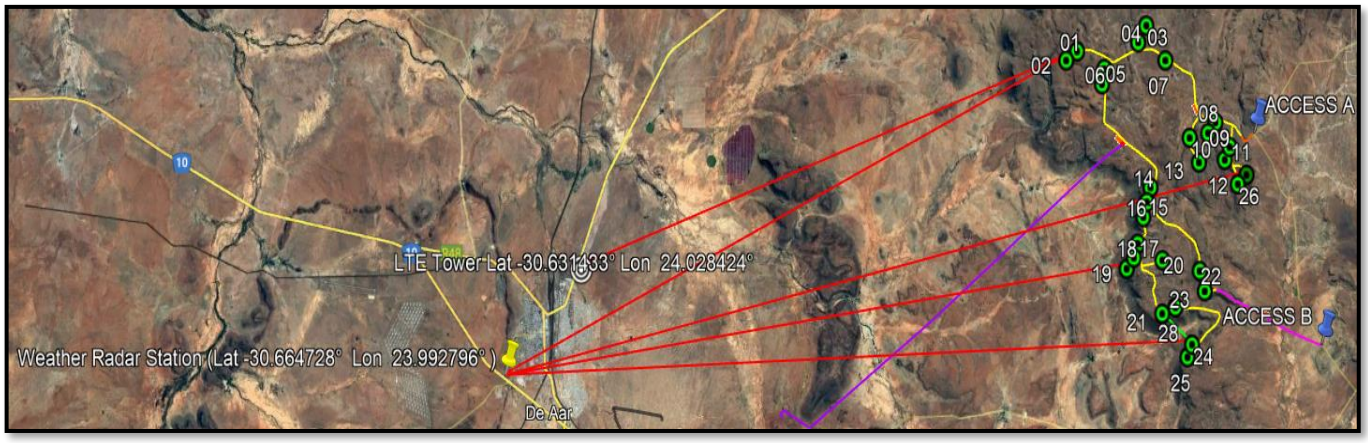


Figure 3 – Proposed WEF with relative distance to a Weather Radar and the Telecommunications Facility

5. TECHNOLOGY DESCRIPTION

A typical wind turbine system has the following building blocks elements:

- Rotor (Blades, hub, and pitch system).
- Nacelle housing the generator, gearbox if not direct drive, yaw system, monitoring/ control systems, power convertor, transformer.
- Tower (concrete or steel).

Some manufacturers choose to remove the power convertors and transformers from the nacelle and place it in the tower or separate facility next to the tower.

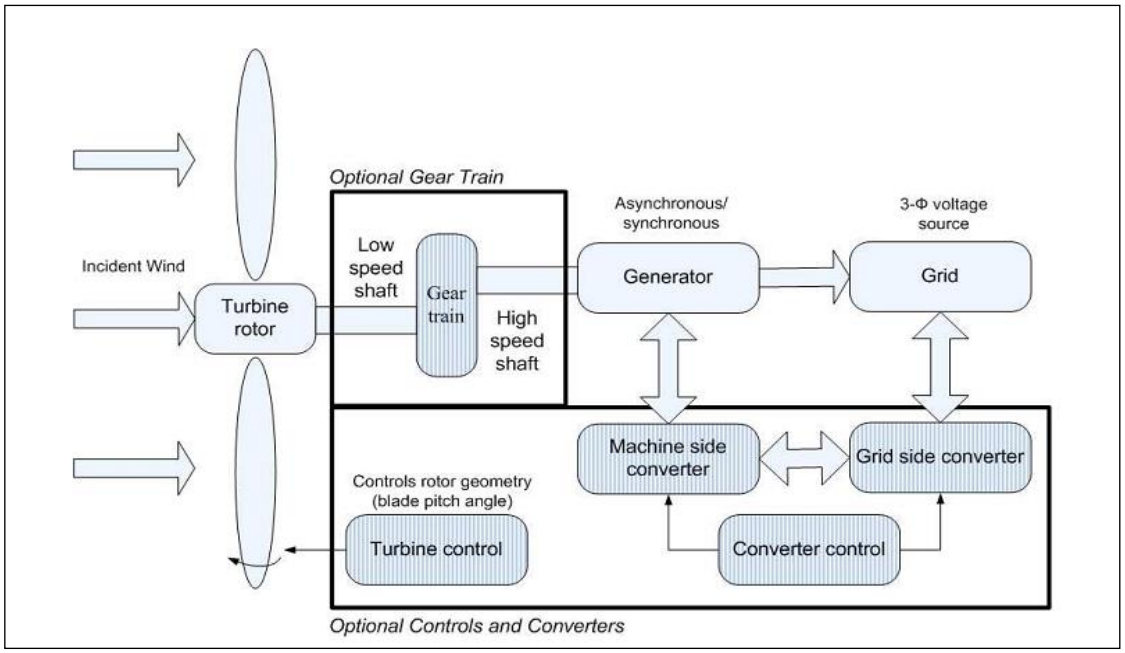


Figure 4 - Generic Wind Turbine Block Diagram

6. RISK IDENTIFICATION

6.1 TECHNOLOGY RISKS

The following building blocks are viewed as potential interference sources:

- Control/ monitoring systems – specially nacelle mounted systems.
- Power conversion equipment (rectifier/ invertor systems).
- Control and operations centre (computer equipment).

6.1.1 Control/ monitoring systems

- Environmental sensors.
- Warning lights.
- Cabinets housing PLC equipment.
- Variable speed drives (yaw and pitch control system).

6.1.2 Control and operations centre

Equipment installed in the control and operations centre should comply with CISPR 32 Class B. No mitigation requirement for equipment installed in the control and operations centre.

6.1.3 Power Convertor

- Thyristor/ IGBT switching rectification and invertor circuits
- UPS for control circuits

7. GOOD PRACTISE RFI MITIGATION METHODS

There are some steps that can be considered when designing a new WEF to minimise the amount of RFI or EMI that can be emitted:

- Properly ground the WEF Turbines to reduce common mode impedance.
- Avoid pigtail connections when installing the grid connections.
- Shield the DC cabling to ensure a good connection to ground.
- Only use electrical/electronic equipment with CE approval.
- Ensure all grid related connections are according to specification. (no gaps between connections)
- Use approved grid cable connectors to avoid unwanted corona and/or sparking.
- Avoid sharp edges at the end of cable connections.

The purpose of electrical bonding is to provide structural homogeneity with respect to the flow of electrical currents, including high frequency currents for proper operation of filters and fault current paths. Bonding also prevents or safely discharges static charges and ensures a good ground connection that will prevent unintentional emissions to occur.

8. CLEARANCE ZONE

The clearance zone around a WEF is the separation distance needed, between the edge of the WEF (source) to a specific EMI sensitive location or infrastructure (victim), for the WEF facility to have no RFI on existing electrical infrastructure. The exact wind turbine equipment that will be used is unknown as no technology partner has been selected yet, thus it is assumed that the inverters and equipment comply to CISPR11 Class A specification [7]. (57 dBµV/m @ 3m which relates to an EIRP of -38.16dBm). The recommended clearance zones are listed in Table 2.

It is stated in the Electronic Communications Act [8] that no product used or manufactured in South Africa may cause unwanted RFI or EMI due to intentional or unintentional transmissions on existing electrical equipment. Thus, to prevent the WEFs unintentional RFI to cause unwanted interference on existing electrical equipment a clearance zone is used.

Table 2 - Clearance Zone Distances calculated using [5]

EMI sensitive location	Distance Between the Edge of a WEF and an EMI sensitive location in meter
Existing Radar equipment ex. Weather radar	400 m
Navigational and communication equipment	300 m
Equipment sensitive to EMI	300 m
Airfield/Airport Radar system	400 m

8.1 COVERAGE MAP, TYPICAL RECEIVER SENSITIVITIES AND SITE TRANSMIT POWER

Coverage maps generated using Radio Mobile RF software [5] is shown below in Figures 5 to 13. In figures 11, 12 and 13 a 1km radius exclusion zone been chosen to account for an unidentified telecommunications tower stated to be 1km away from the proposed WEF. Figures 5 to 10 represent the pathloss and received power level (PathLoss, Rx level) from three different wind turbines to the identified Weather Radar Installation and the Telecommunications facility located near De Aar.

The receive power level at the Weather Radar Installation as well as the Telecommunications facility is less than the receiver sensitivities listed in Table 3. The received power level 1km away from the three chosen wind turbines is less than the GSM/LTE/GPRS receiver sensitivities listed in Table 3.

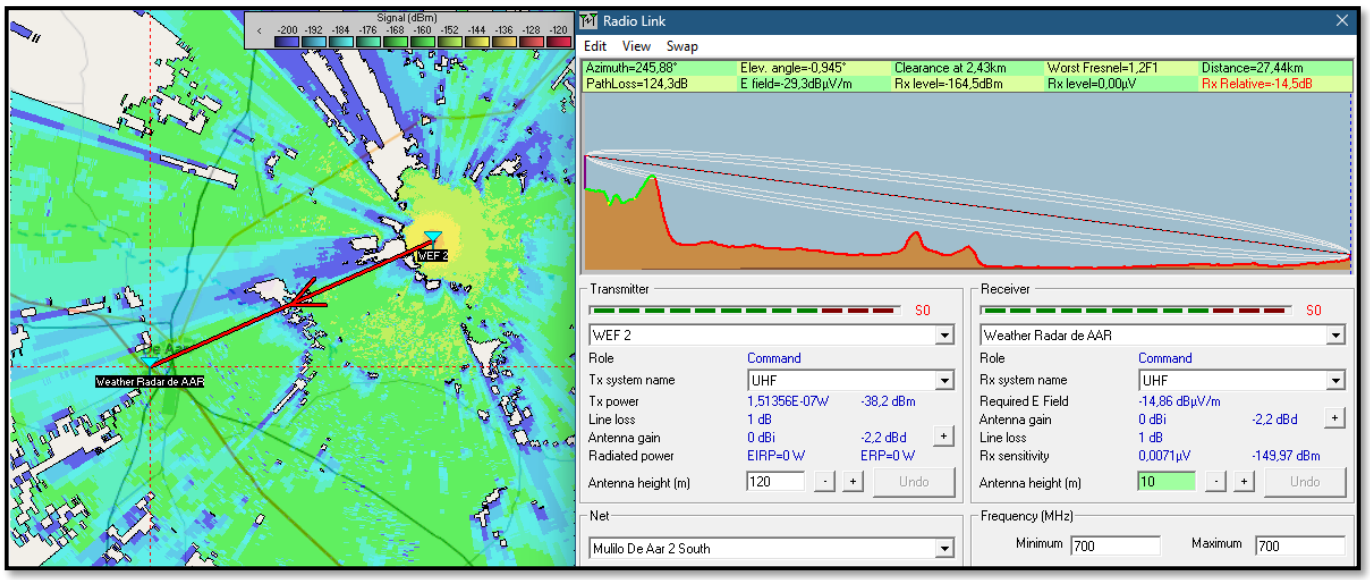


Figure 5 - Signal Strength Coverage Map between WEF2 and the De Aar Weather Radar Installation

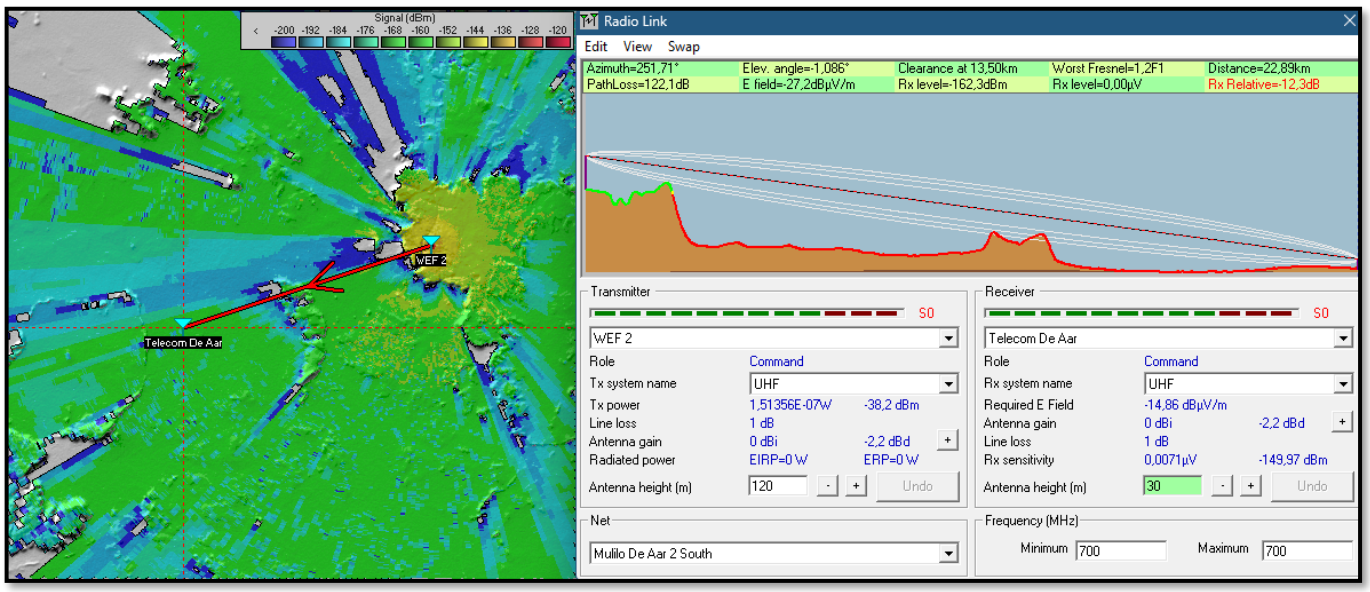


Figure 6 - Signal Strength Coverage Map between WEF2 and the nearest Telecommunications facility

*note – WEFx referes to an allocated wind turbine in the Mulilo De Aar 2 South WEF project.

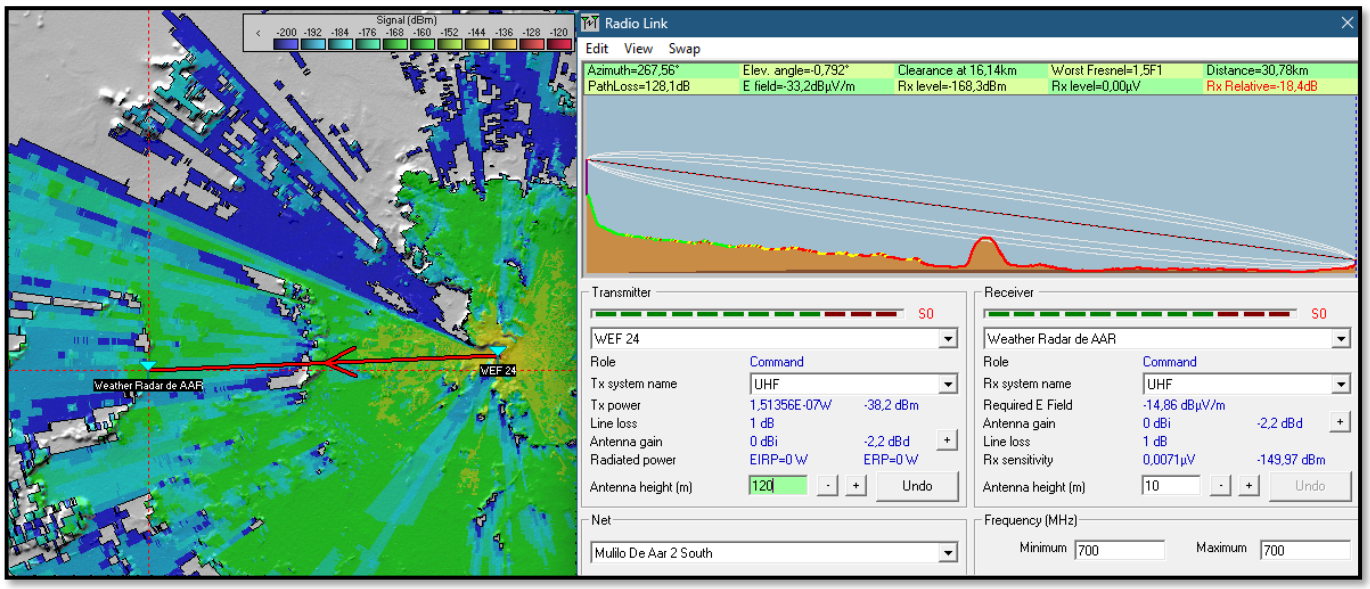


Figure 7 - Signal Strength Coverage Map between WEF24 and the De Aar Weather Radar Installation

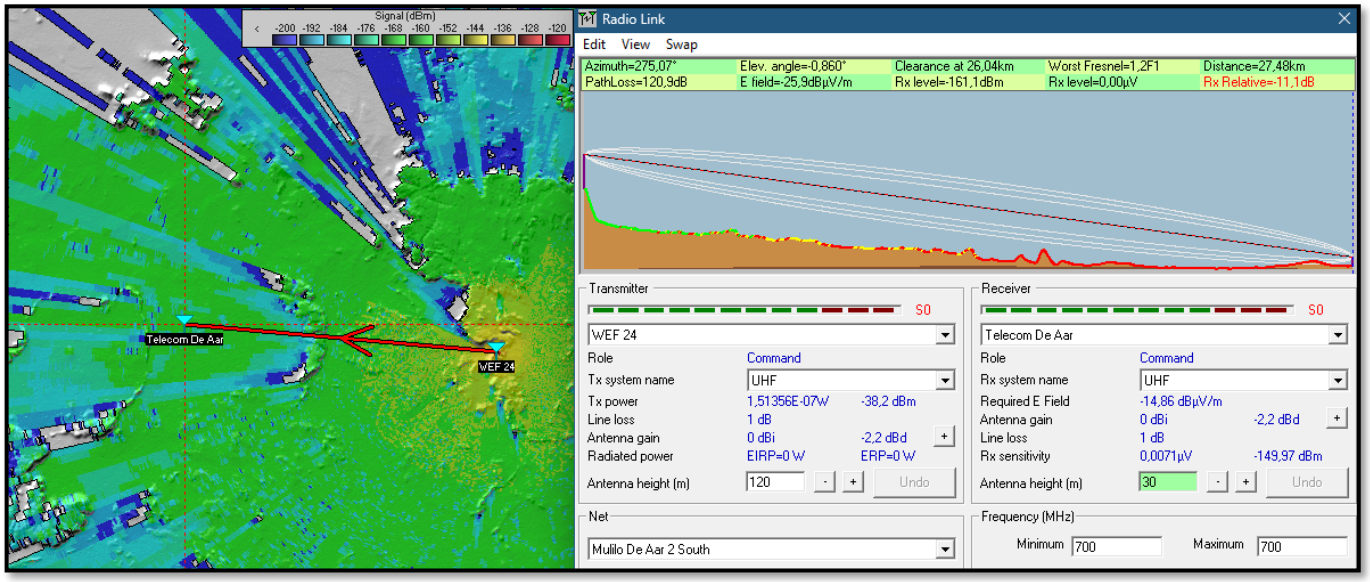


Figure 8 - Signal Strength Coverage Map between WEF24 and the Nearest Telecommunications Facility

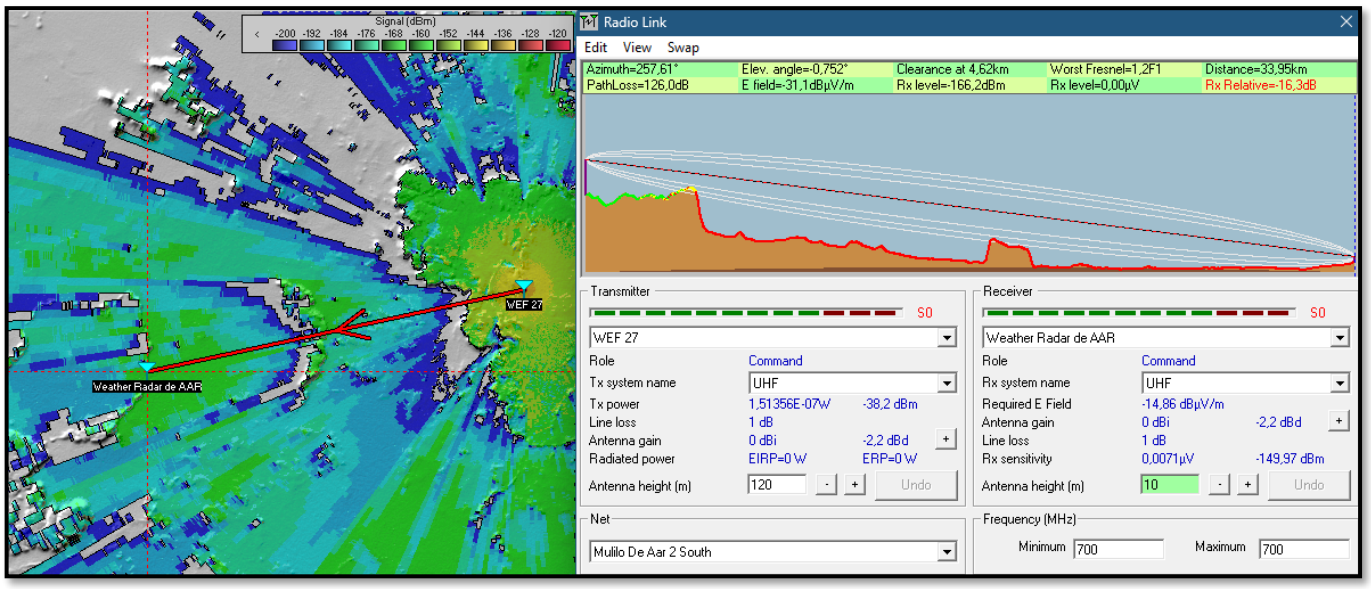


Figure 9 - Signal Strength Coverage Map between WEF27 and the De Aar Weather Radar Installation

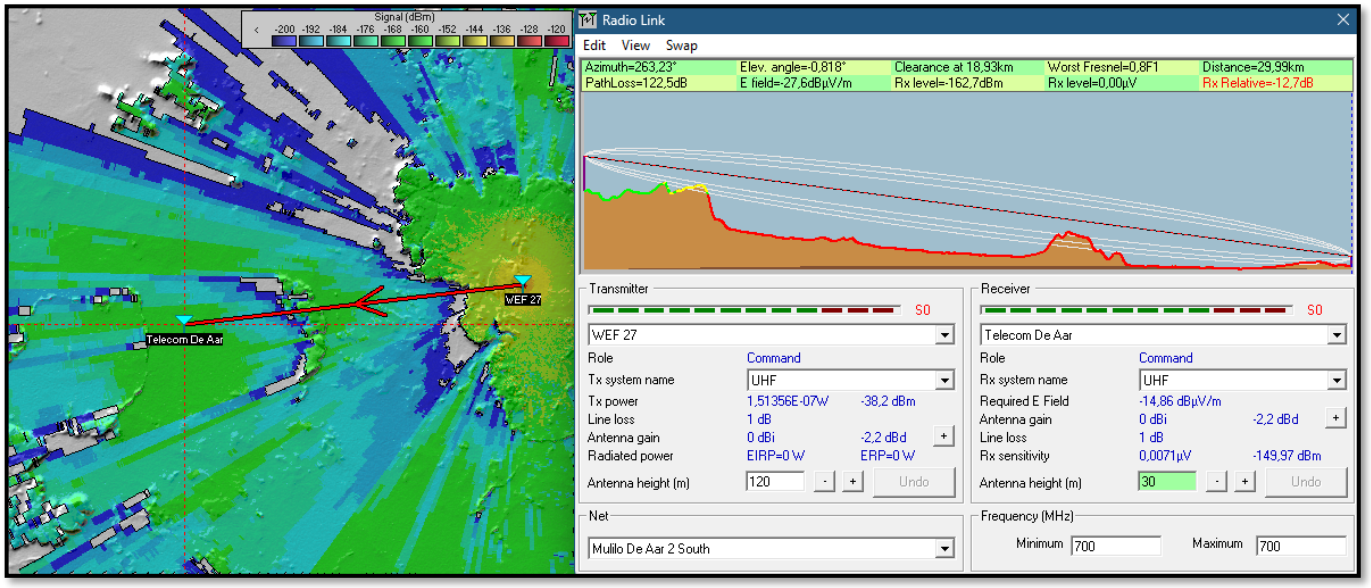


Figure 10 - Signal Strength Coverage Map between WEF27 and the Nearest Telecommunications Facility

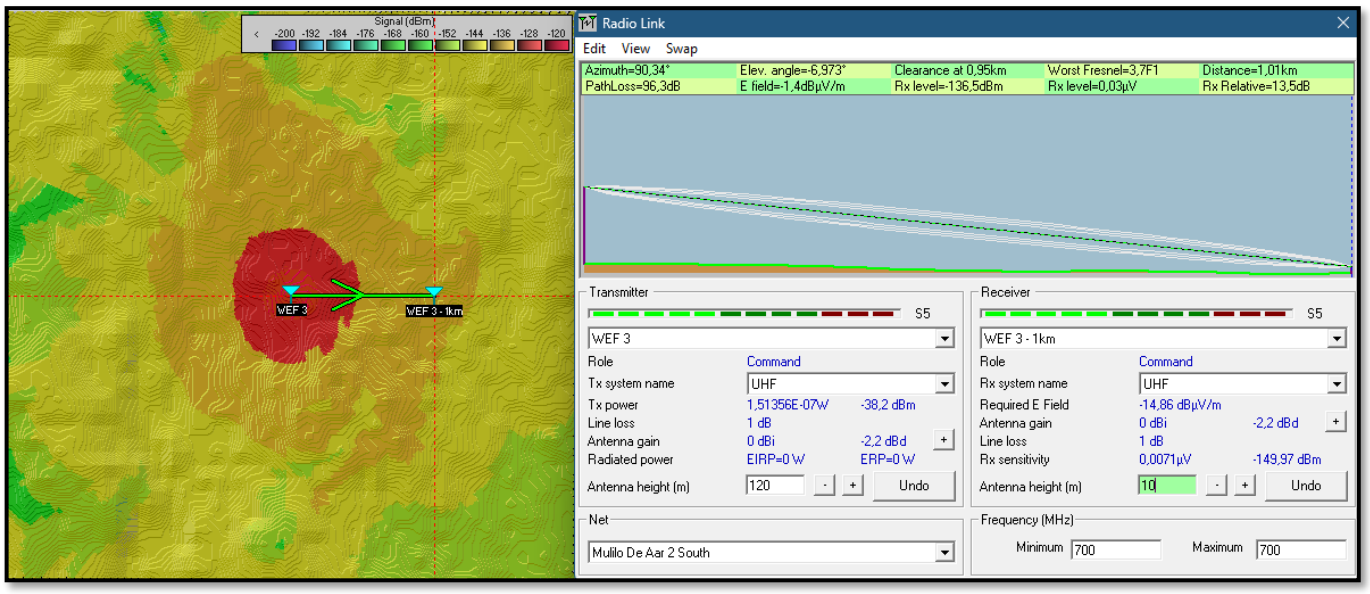


Figure 11 - Signal Strength Coverage Map 1km away from WEF3

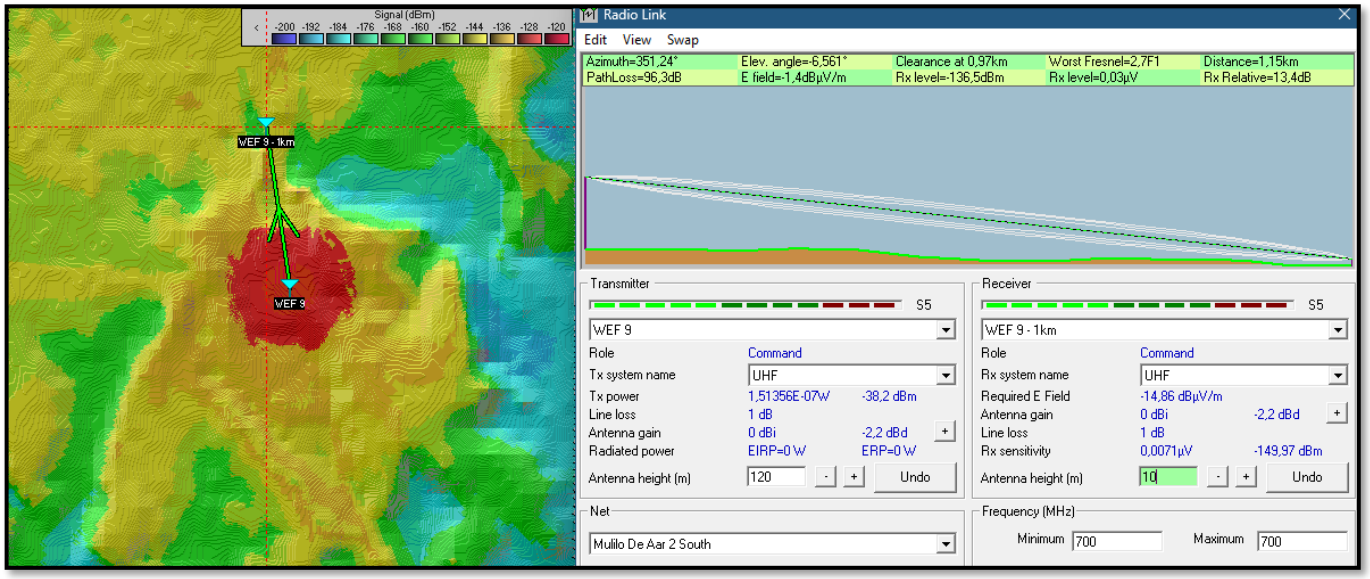


Figure 12 - Signal Strength Coverage Map 1km away from WEF9

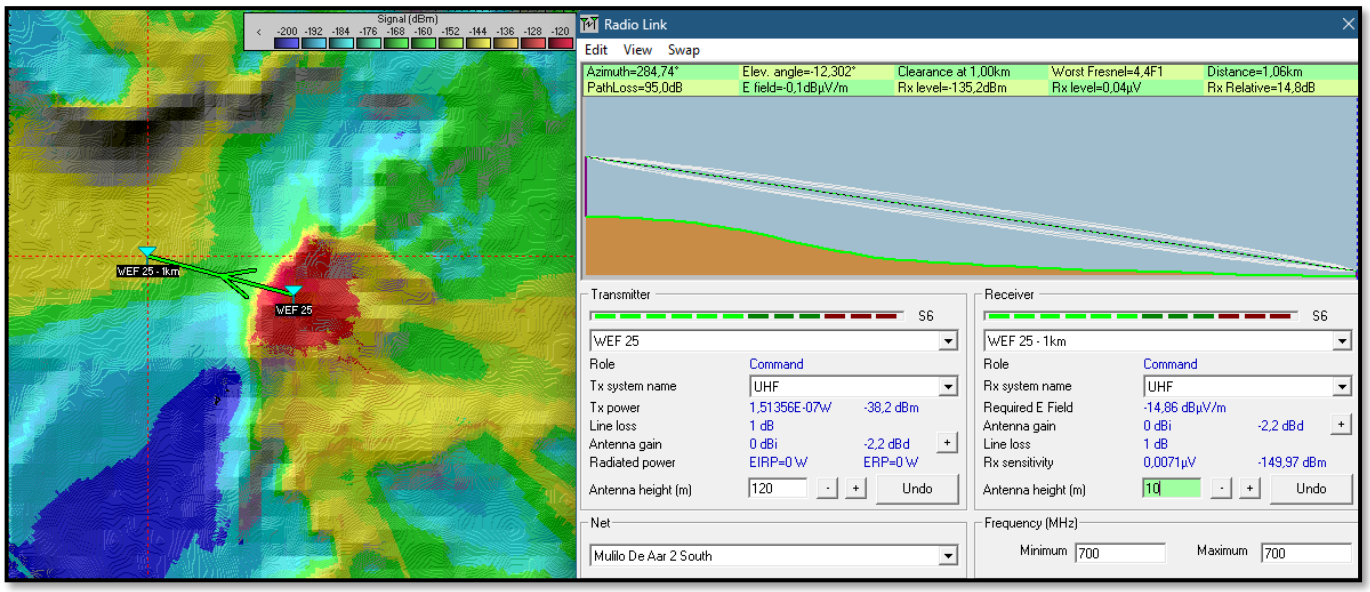


Figure 13 - Signal Strength Coverage Map 1km away from WEF25

Table 3 - List of typical sensitivities from EMI sensitive equipment

Receiver	Typical Sensitivities
LoRa 2.4GHz	-130 dBm
Pulse Radar 1-12GHz	-94 dBm
Wifi (common 802.11g) 2.4/5 GHz	-85 dBm
GSM/LTE/GPRS 0.85-2.1GHz	-102 dBm
UHF 300MHz	-100 dBm
Bluetooth 2.4GHz	-82 dBm

9. CUMULATIVE EFFECT

Non-correlated noise sources such as PV facility inverters or Wind Turbine electric/electronic equipment in close proximity could increase the clearance zone required around a specific renewable energy plant site, as the cumulative level of unintentional radiated emissions will be higher. A standard factor of 10 $\log_{10}$ N, where N = amount of renewable energy plants in the direct vicinity, is used to account for the increased radiated emission levels [9]. For the De Aar 2 South WEF there are 11 renewable resource locations in a 30km radius.

For this theoretical worst-case scenario, the possible increase in the cumulative radiated emission levels will be 10.4 dB, increasing the transmit power level to -27.8dBm.

The received power levels represented in Figures 14 to 22 are less than the receiver sensitivities at the Weather Radar Installation as well as the Telecommunications facility listed in Table 3. The cumulative effect increases the received power, but not enough to cause any unwanted RFI or EMI to surrounding electrical equipment.

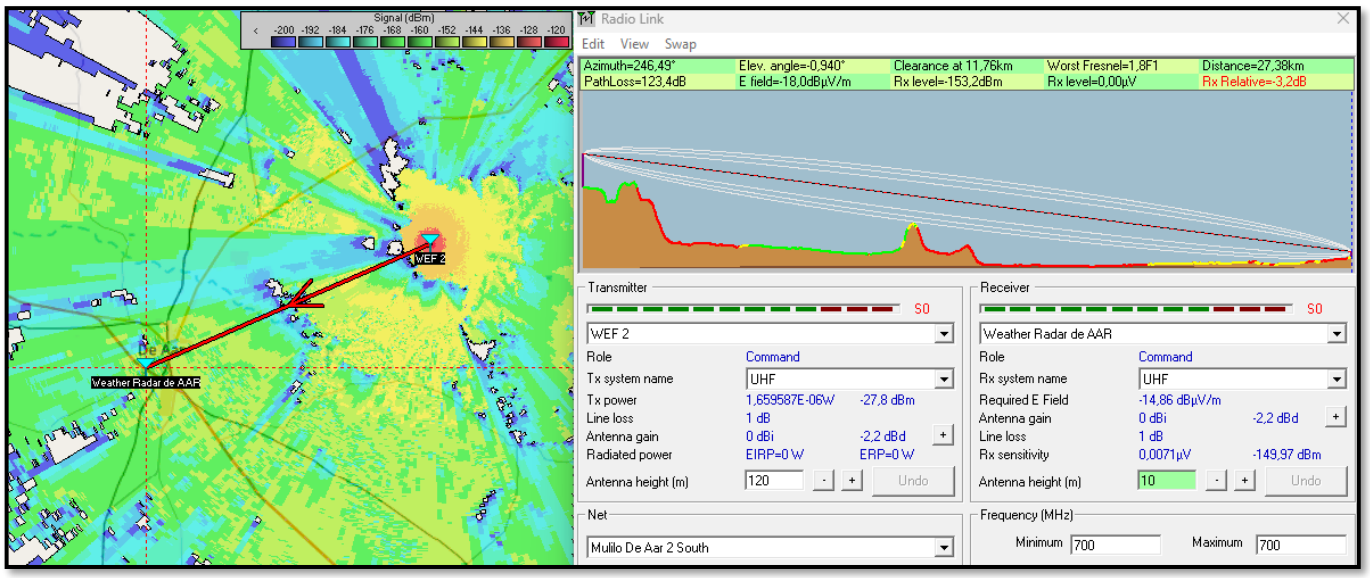


Figure 14 - Signal Strength Coverage Map between WEF2 and the De Aar Weather Radar Installation with the cumulative effects considered

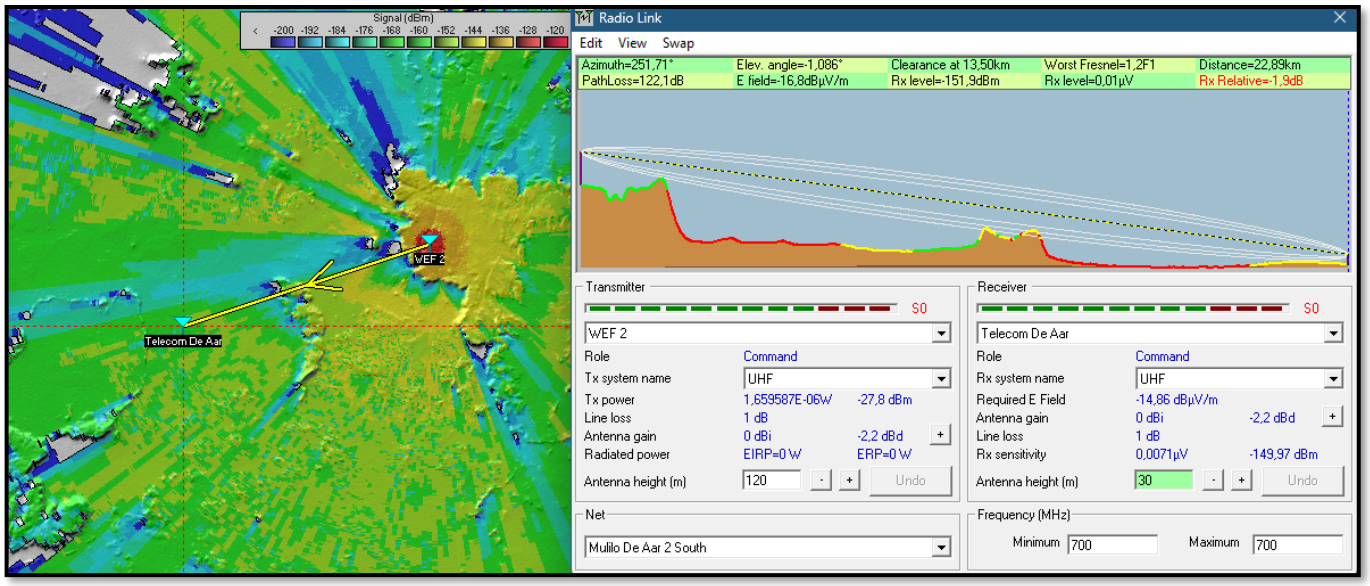


Figure 15 - Signal Strength Coverage Map between WEF2 and the nearest Telecommunications facility with the cumulative effects considered

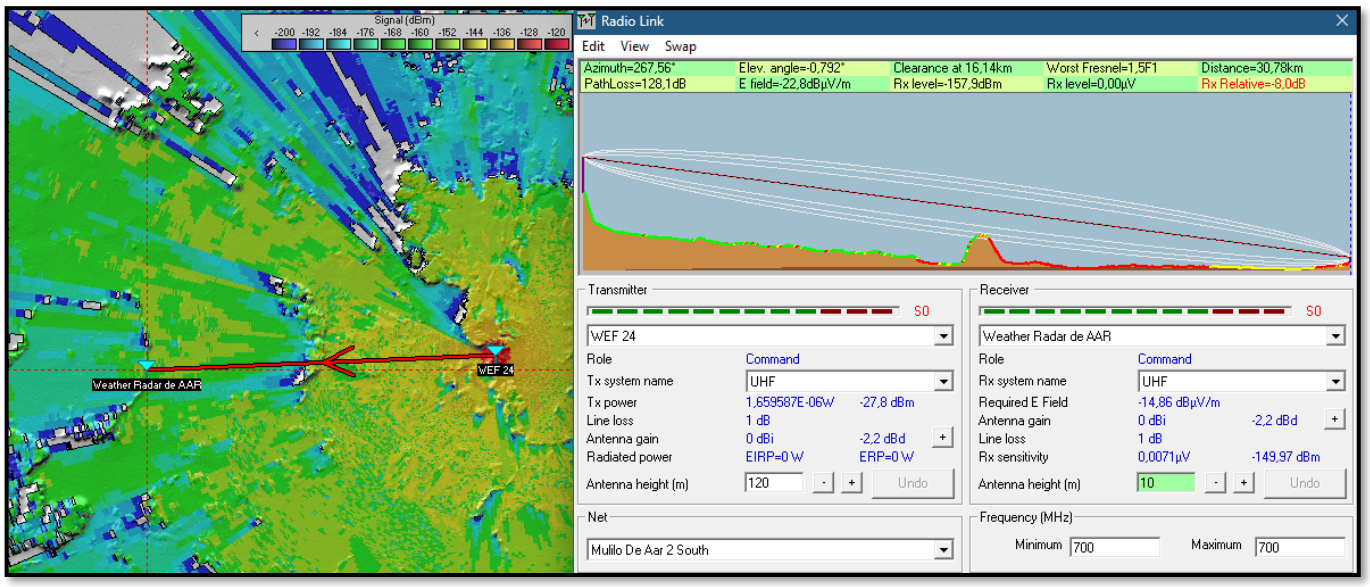


Figure 16 - Signal Strength Coverage Map between WEF24 and the De Aar Weather Radar Installation with the cumulative effects considered

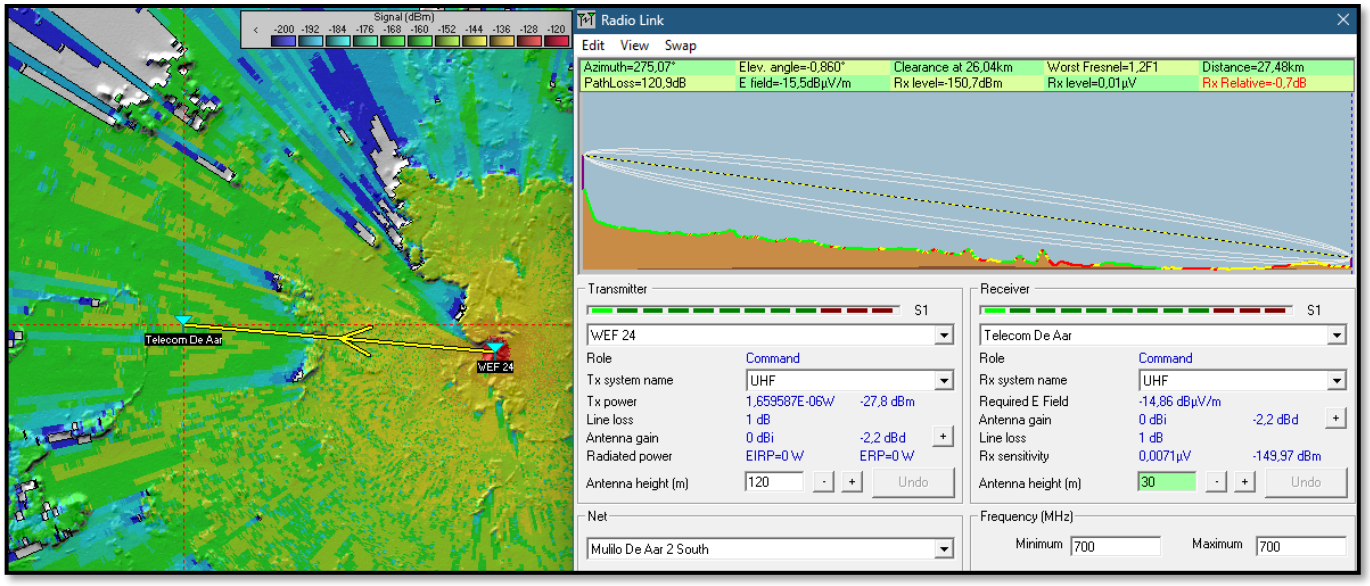


Figure 17 - Signal Strength Coverage Map between WEF24 and the nearest Telecommunications facility with the cumulative effects considered

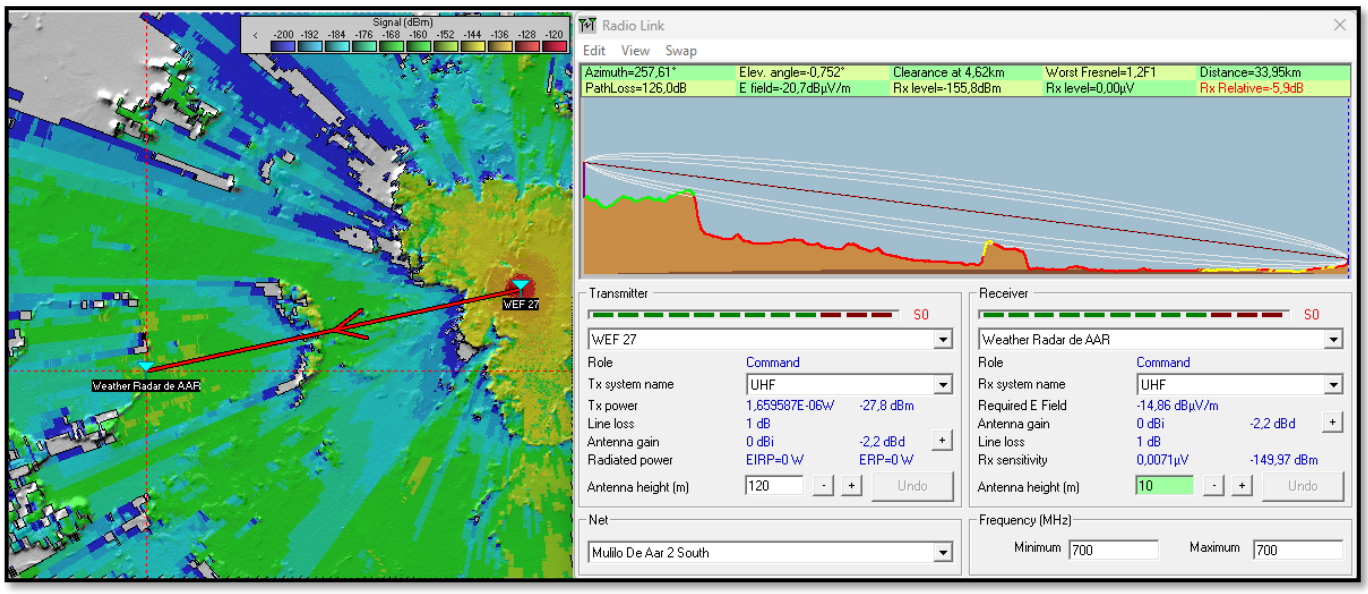


Figure 18 - Signal Strength Coverage Map between WEF27 and the De Aar Weather Radar Installation with the cumulative effects considered

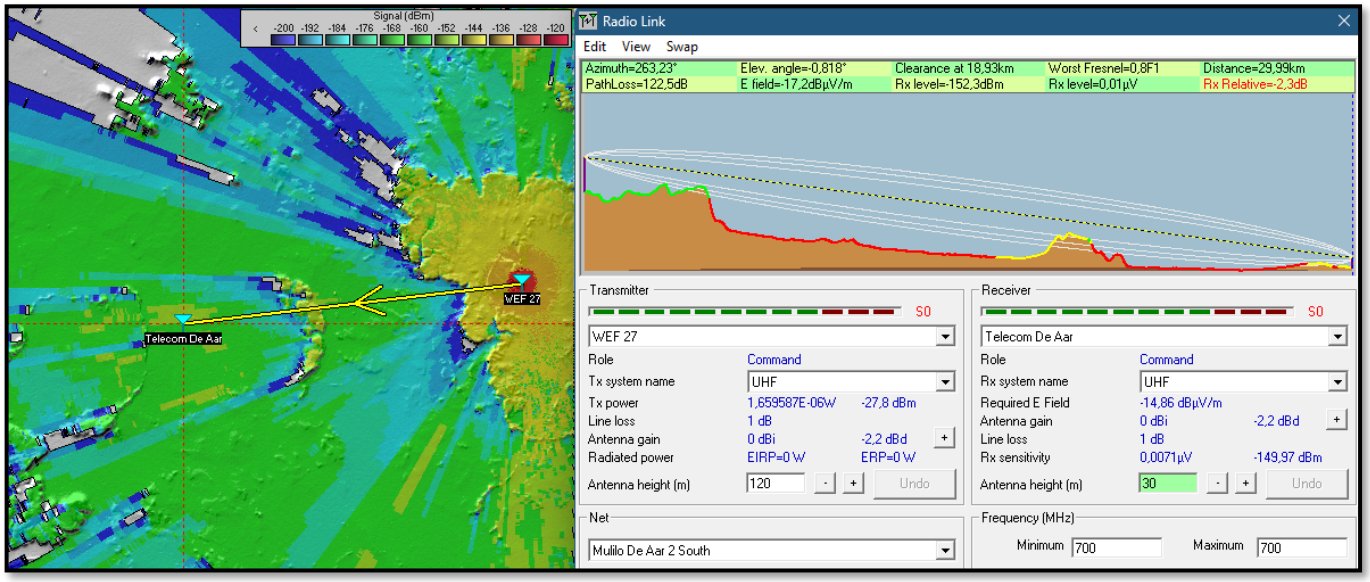


Figure 19 - Signal Strength Coverage Map between WEF27 and the nearest Telecommunications facility with the cumulative effects considered

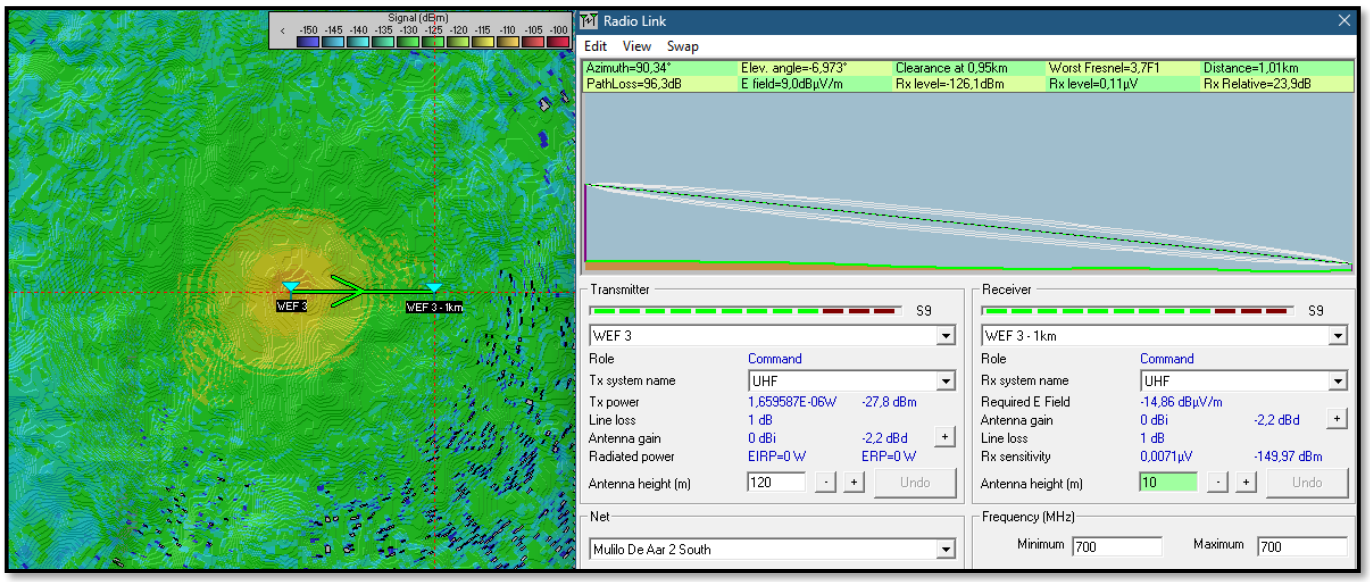


Figure 20 - Signal Strength Coverage Map 1km away from WEF3 with the cumulative effects considered

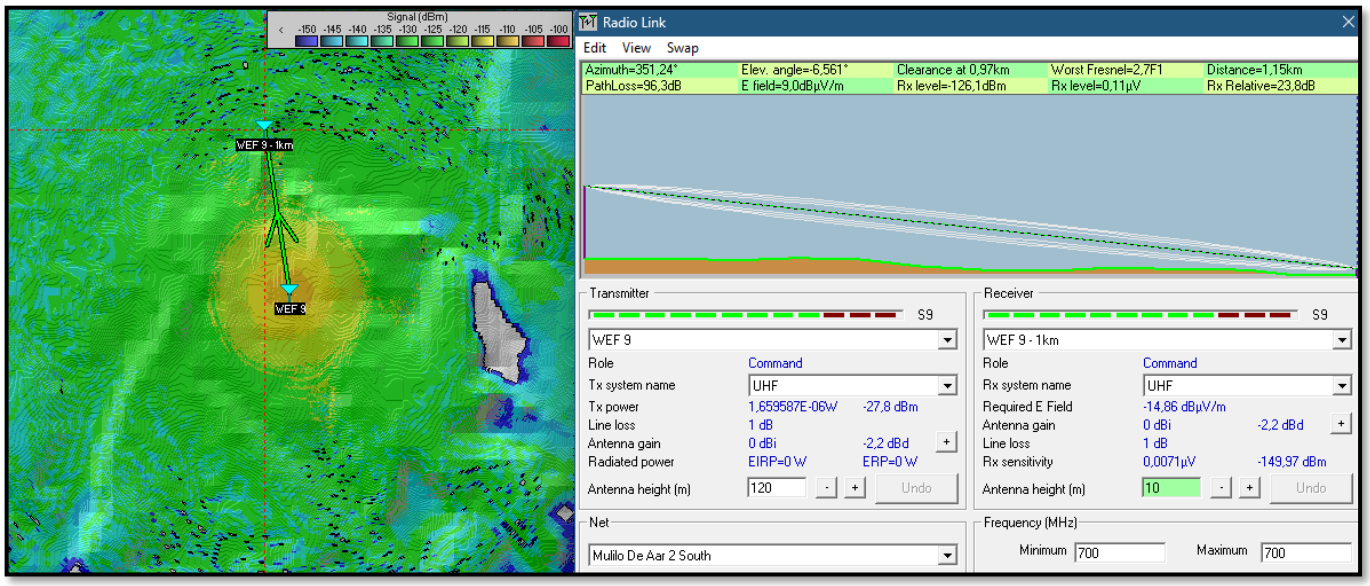


Figure 21 - Signal Strength Coverage Map 1km away from WEF9 with the cumulative effects considered

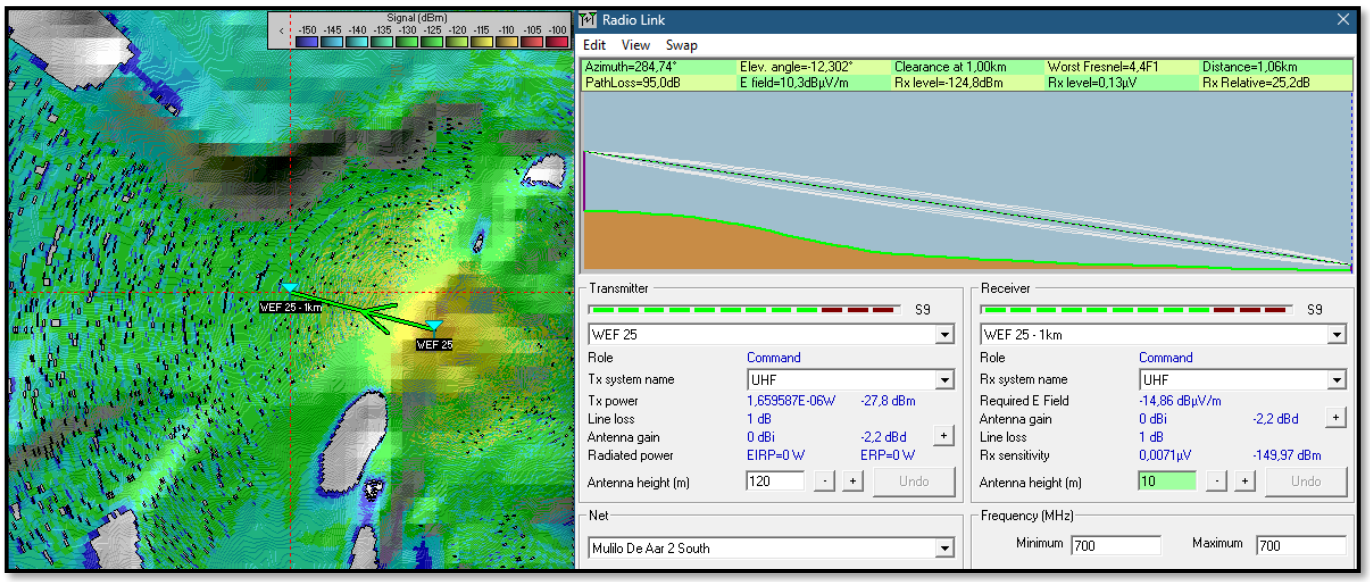


Figure 22 - Signal Strength Coverage Map 1km away from WEF25 with the cumulative effects considered

10. CONCLUSION

The exact location of the telecommunications facility within 1km from the proposed facility was not identified, thus a 1km radius point around three different wind turbine locations was used to determine the received power at that distance with and without the cumulative effect considered. In both cases, the received power level at 1km is lower than the GSM/LTE/GPRS receiver sensitivities.

According to the Radio Mobile data, the proposed WEF will have no RFI on the Weather Radar Installation nor the telecommunications facility, assuming that the sites emit less RFI than the CISPR 11 class A levels. If the exclusion zones, listed in Table 2, are adhered to when the WEF facility is constructed, the proposed facility will have no RFI influence on existing electrical/electronic equipment. This statement applies to the entire proposed region seen in Figure 3.

Table 3 contains possible EMI sensitive receivers with their respective sensitivities that can be used in the area. According to the worst-case cumulative coverage data generated in Radio Mobile seen in figures 14 to 22, the receivers at the Weather Radar Installation, the Telecommunications facility and the surrounding area will not be affected by the proposed WEF. There might be slight interference to LoRa applications within 1km from the WEF turbines, thus avoid using LoRa within this area.

A further detailed assessment will not be required based on the findings from the Radio Mobile data as no RFI risk was identified to classify the site as a High sensitivity site. The site can be classified as a Low sensitivity site.

11. REFERENCED AND APPLICABLE DOCUMENTS

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[3] REPO Electro-Magnetic Interference from Solar Photovoltaic Arrays (April 2017)

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