Sure Partners Limited

ARKLOW BANK WIND PARK PHASE 2
ONSHORE GRID INFRASTRUCTURE

VOLUME III
Chapter 18 APPENDICES

Appendix 18.1 EMF Study

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Appendix 18.1

EMF Assessment

A.18.1 Electric and Magnetic Field Assessment

Introduction

This section of the Environmental Impact Assessment has been prepared by Compliance Engineering Ireland Ltd and provides an assessment of the electrical and magnetic field impacts associated with the Arklow Bank 220kV underground cable circuit as described in **Chapter 5** *Description of Development* of the Environmental Impact Assessment Report (EIAR).

For ease of reading and understanding, the following terms referred to throughout this technical appendix are described, including Electromagnetic Compatibility (EMC), Electromagnetic Interference (EMI) and Electromagnetic Fields (EMF). EMC relates to the ability of different EM (Electromagnetic) devices to function properly when they are situated in the same environment, i.e. it relates to the compatibility between different devices. EM devices can generate and propagate energy causing EMI. Devices can also receive and be interfered with by energy generated and propagated by other devices in the same environment. If an EM device is not compatible with other devices in the same environment, EMI can lead to the device or other devices not functioning properly. EMF relates to electromagnetic fields and human health including livestock and plants. If sufficiently strong, electromagnetic fields can have a physiological impact and affect human health.

EMF is a phenomenon that takes the form of self-propagating waves in air or in water. It consists of electric and magnetic field components which oscillate in phase perpendicular to each other and perpendicular to the direction of energy propagation.

EMF is classified into several types according to the frequency of its wave; these include (in order of increasing frequency and decreasing wavelength) radio waves, microwaves, terahertz radiation, infra red radiation, visible light, ultraviolet radiation, x-ray and gamma rays. The electromagnetic fields from power lines at 50 Hz are at the bottom end of the electromagnetic spectrum and have a long wavelength compared to other EM fields listed. A small and somewhat variable window of frequencies is sensed by the eyes of various organisms; this is what we call the visible spectrum or light. EMF carries energy and momentum that may be imparted into matter with which it interacts. The wavelength at 50 Hz is in a part of the electromagnetic spectrum that imparts the lowest amount of energy.

Overview

Extremely Low frequency (ELF) EMF including frequencies from 0 Hz to 100 kHz surround all things that:

- Generate (e.g. electricity generators);
- Transmit (e.g., Substations, power lines and wiring); or
- Use electricity (e.g., appliances and other devices).

Thus, exposure to EMF are common in modern life. These fields will be generated in the vicinity of the proposed development. This chapter addresses the nature of ELF-EMF and the levels associated with the proposed cable route, as well as the scientific consensus on potential relationships between ELF-EMF and health.

Methodology

The baseline environment is defined as the existing environment against which future changes can be measured. This section presents the methodology used in assessing the impact on the baseline environment. As well as considering the relevant guidance with respect to environmental impact, the scope and methodology for the impact assessment has been devised in consideration of the following guidelines:

- International Commission on Non-Ionising Radiation Protection (ICNIRP) Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz). Health Physics 74 (4): 494-522; 1998
- European Commission (EC) Council Recommendation on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) 1999/519/EC
- ICNIRP Guidelines for limiting exposure to time varying electric and magnetic fields (1 Hz–100 kHz) Health Physics 99(6):818-836; 2010
- EU Electromagnetic Compatibility Directive 2014/30/EU on the approximation of the laws of the Member States relating to electromagnetic compatibility

Limit Values

In terms of public exposure, Irish Government policy is to comply with the 1998 ICNIRP Guidelines in the terms of the 1999 EU Recommendation.

A panel of independent scientists, convened by Ireland's Department of Communications, Marine and Natural Resources (DCMNR), published a brief Q&A document entitled "Health Effects of Electromagnetic Fields." The conclusions of this report were consistent with those of International Agency for Research on Cancer (IARC), the World Health Organisation (WHO) and other national and international agencies. In relation to ELF-EMF, the report stated, "No adverse health effects have been established below the limits suggested by international guidelines."

International guidelines for ELF-EMF were set in 1998 by the ICNIRP, a formal advisory agency to the WHO. The ICNIRP reviewed the research and concluded it was insufficient to establish exposure guidelines on the basis of long-term health effects; on the other hand, the agency found sufficient evidence for short-term, neurostimulatory effects at very high field levels and exposure guidelines were established to prevent against this effect. The ICNIRP 1998 Guidelines subsequently formed the basis of the EU EMF Recommendation in 1999.

In 2010 ICNIRP issued updated guidelines, which reviewed the research since the 1998 Guidelines and replaced previous recommendations given by ICNIRP for this frequency range. The proposed 220kV overhead and underground transmission lines and substation will comply with the same guidelines.

According to international authoritative agencies, the cumulative body of evidence indicates that ELF-EMF from power lines does not have any adverse effects on health at the levels below ICNIRP guidelines. None of these scientific agencies considered it necessary or appropriate to limit the construction of electric facilities or recommend exposure standards below the ICNIRP limits.

The acceptable levels of electric and magnetic fields are published by ICNIRP. The 1998 guidelines and 2010 guidelines are reproduced below in **Table 1**. The EU EMF Recommendation 1999/519/EC for public exposure adopts the 1998 guidelines.

Table 1: Health Guidelines

Exposure Characteristics	Electric Field Strength kV/m	Magnetic Flux Density, µT
ICNIRP		
-1998 General Public Reference Level	5	100
-2010 General Public Reference Level	5	200

The baseline EMF levels have been defined through a desktop study and consultation with relevant stakeholders. The proposed development is then assessed to determine if there is an impact.

Magnetic flux densities for AC magnetic fields are reported using units of microtesla (µT) and AC electric fields are reported as kilovolts per metre (kV/m).

Assessment Methodology

The electromagnetic fields have been calculated by a proprietary computer modelling package SoCal Edison 3.5.0A produced by Southern Californian Edison which is based on the industry standard method using the Biot Savart Law.

Study Area

The proposed development will provide:

- Landfall for two offshore export cable circuits from the High Water Mark (HWM) to two Transition Joint Bays (TJB) at Johnstown North, located approximately 4.5km northeast of Arklow Harbour,
- Connection by two underground 220kV high voltage alternating current cable circuits, and fibre optic cables over a distance of c. 6km, from the landfall to the new onshore 220kV substation,

- A new onshore 220kV substation, to be located at Shelton Abbey, north of the Avoca River, approximately 2.1km northwest of Arklow Town consisting of two connected compounds:
    1. The transmission compound with the infrastructure to physically connect to the NETN, and
    2. The connection compound with the infrastructure to allow the connection of the windfarm in accordance with EirGrid grid code requirements.
- Flood defence improvement works to the existing Avoca River Business Park flood defences located c. 500m west of the substation site;
- A 220kV overhead line connection from the new 220kV substation at Shelton Abbey to the existing 220kV transmission network located c. 200m from the substation site.

A full description of the proposed development is presented in **Chapter 5** *Description of Development.*

The study area has been defined with reference to the potential for impact from the proposed onshore grid development and the available relevant information. The proposed development is shown in **Figure 1**. The dimensions of the study area are shown in **Table 2**.

Table 2: Study Area

Criteria	Distance
Identification of land uses where sensitive receptors and/or people and/or animals are located.	Within 100m of the Proposed Development

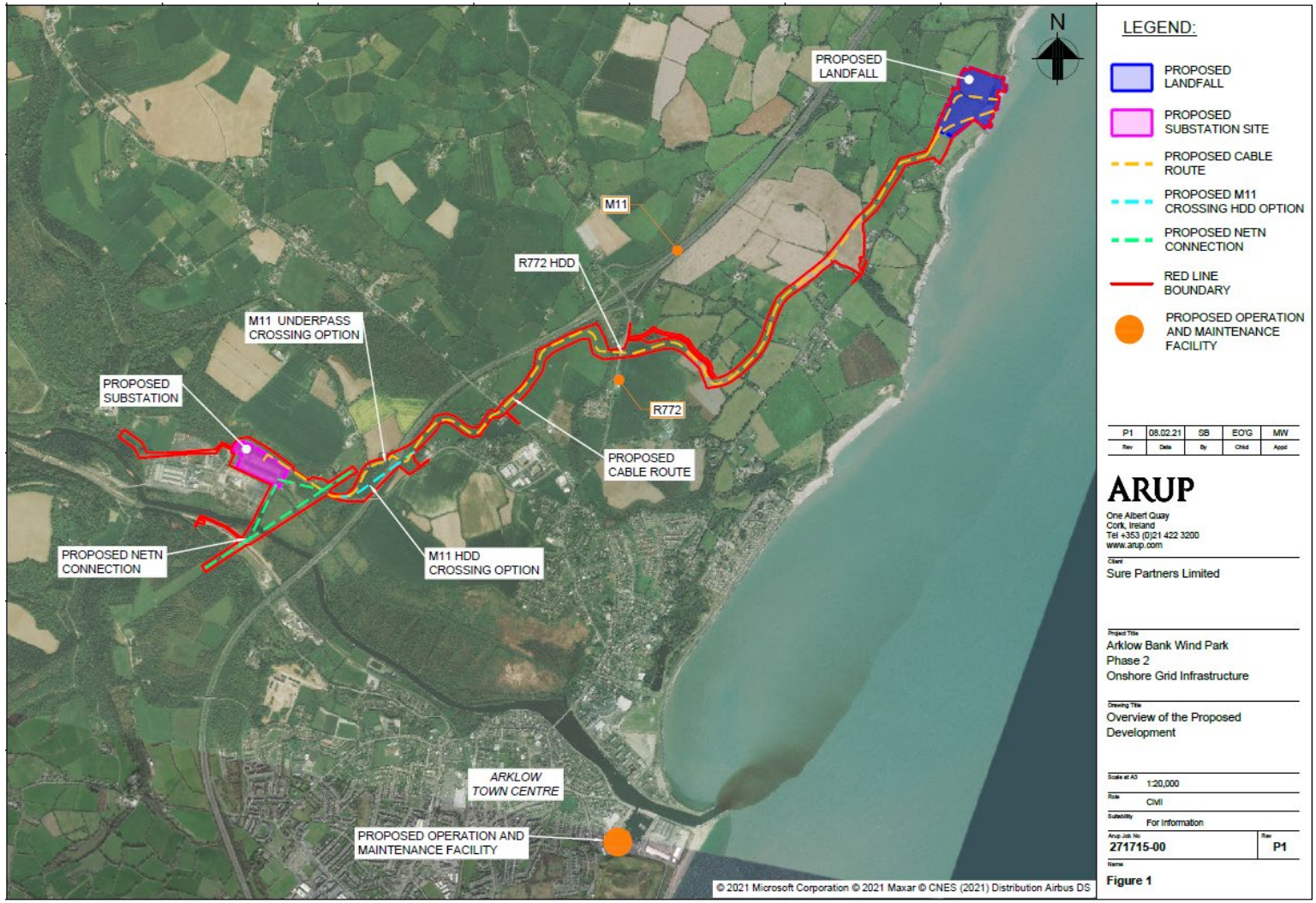


Figure 1: Proposed Onshore Grid Infrastructure

Potential Impacts of the Proposed Development

Electromagnetic Compatibility

Disruption of normal household appliances may occur when magnetic flux densities of 3.8 μT (microtesla) or more are present as defined by standards listed under the EU EMC Directive 2014/30/EU. For the proposed development, magnetic flux densities of 3.8 μT do not persist at distances of more than 10m from the cable route under full load conditions for either a flat or trefoil cable arrangement. Consequently, in the case of the proposed development and the potential sources that exist, EMI is highly unlikely to have any impact on even the most sensitive equipment at distances of more than 10m. Therefore, the development is highly unlikely to have any impact on domestic appliances.

Electromagnetic Fields

Landfall

As described in **Chapter 5** *Description of Development*, each of the two offshore cable circuits, of up to 266mm outside diameter (OD), will consist of a three-core cable i.e. three electrical conductors within the one cable, to ease installation. The cable will also contain two fibre optic cables. The separation distance of the two offshore cable circuits is up to 50m and both will be located a maximum of 15m below ground.

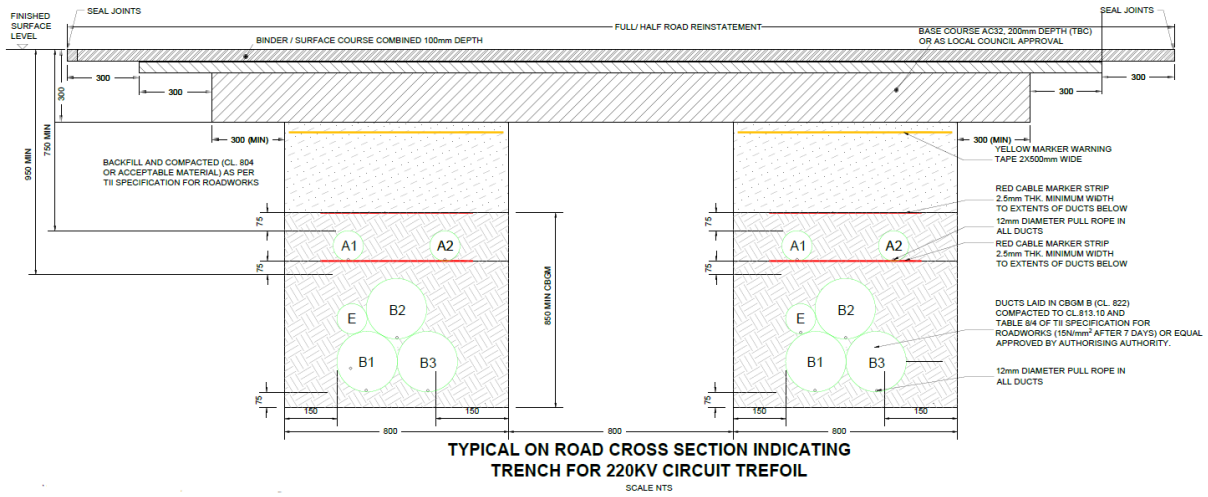
At the joint between the onshore and offshore cable circuits, the three-core offshore cable is split out and each conductor is jointed to three separate onshore single-core cables at the Transition Joint Bay.

The EMF assessment of the cable circuits at the landfall is included in the cable route assessment presented below.

Cable Route

The three cables of each cable circuit will be positioned in a trefoil formation (see **Figure 2**), for HDD road crossings and along the roads from the M11 crossing to the substation. For most of the route, however, the cables will be laid in flat formation separated by sufficient spacing (see **Figure 3**) to achieve the required electrical rating.

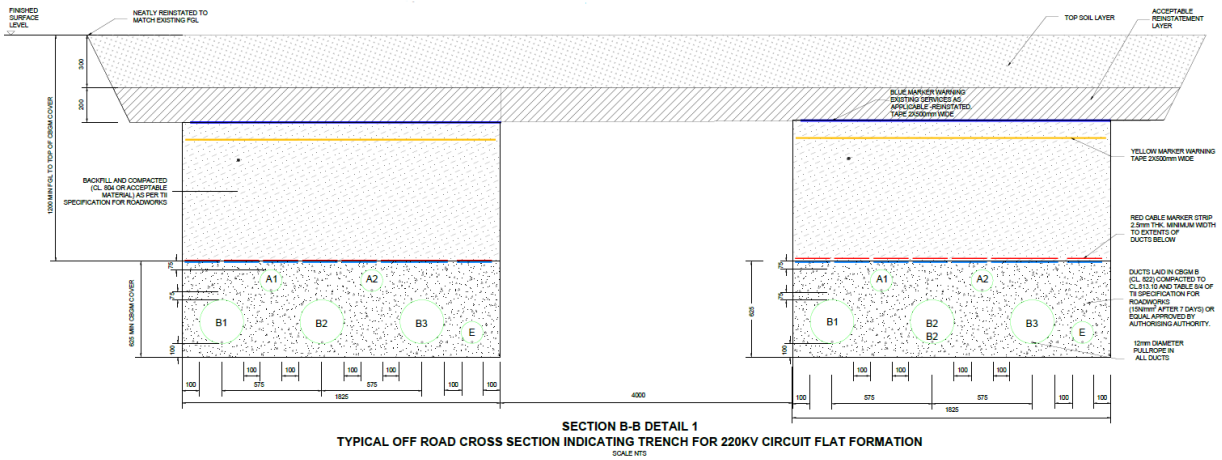
The minimum width per cable trench will be 800mm and the maximum will be 1825mm. The width of the trench will vary with depth of cover (the deeper the cables are buried, the wider the trench may become).



TYPICAL ON ROAD CROSS SECTION INDICATING TRENCH FOR 220KV CIRCUIT TREFOIL

SCALE NTS

Figure 2: Indicative Trench Cross Section – Trefoil Arrangement



SECTION B-B DETAIL 1
TYPICAL OFF ROAD CROSS SECTION INDICATING TRENCH FOR 220KV CIRCUIT FLAT FORMATION

SCALE NTS

Figure 3: Indicative Trench Cross Section – Flat Arrangement

The magnetic fields at maximum loading of the underground cable circuits are shown in **Figures 4** and **5**. The levels have been calculated for a height of 1m above ground in accordance with European standards.

The levels have been calculated using the maximum power capability of the circuits which is significantly greater than the levels that would typically flow. The magnetic field emissions are directly proportional to the load on the cable. These levels have been calculated for a load of 520MW, 260MW on each circuit.

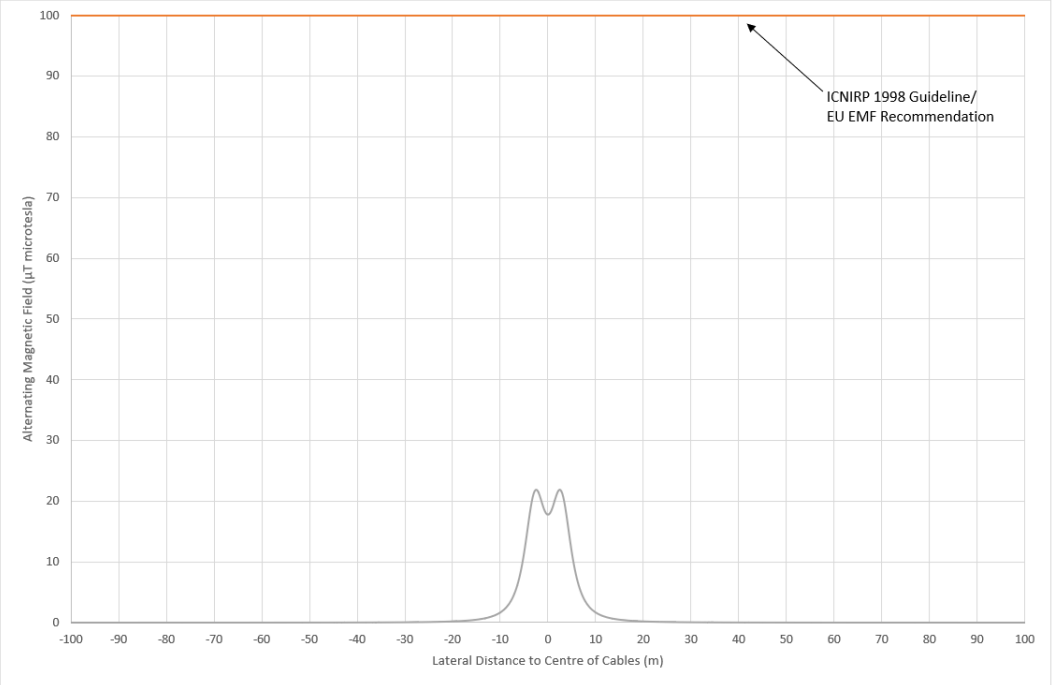


Figure 4: Magnetic Fields from Underground Cable Circuits, Flat Arrangement

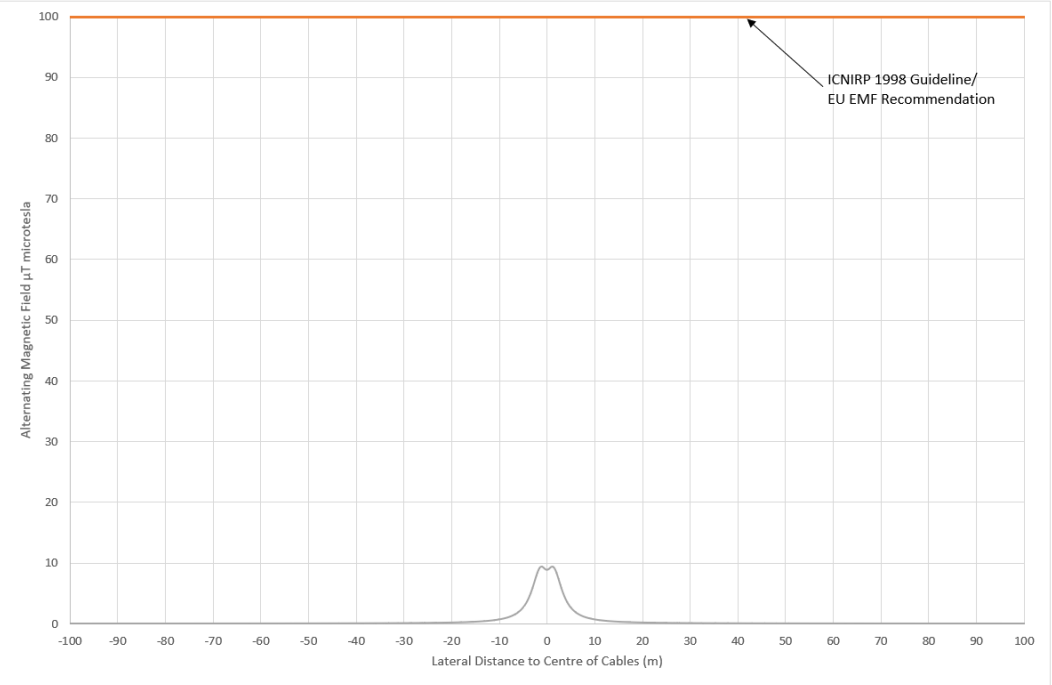


Figure 5: Magnetic Fields from Underground Cable Circuits, Trefoil Arrangement

The flat arrangement generates higher levels of magnetic fields compared to the trefoil arrangement. At all locations, the magnetic field levels are below the EMF Recommendation/ICNIRP 1998 public limit, including directly above the underground cable circuits.

The closest dwelling to the new section of circuit is 10m. At this distance, the magnetic field level is 0.68 µTon full load for the trefoil arranged cables and 1.6 µT for flat arranged cables. This is below the levels at which domestic appliances might be affected.

220kV Substation

The proposed development also comprises a 220kV substation which contains transformers, switchgear, STATCOMs, harmonic filters, shunt reactors, inductors and capacitors as described in **Chapter 5** *Description of Development*.

These components have been assessed and it has been verified that the electromagnetic field strengths are compliant with the guidelines. The components considered produce magnetic fields that decrease with the cube root of distance, as a result, any magnetic fields are very localised and will not propagate beyond the boundary fence. The substation design will be compliant with the EMC Directive 2014/30/EU.

NETN Connection

There will be a relatively short section of new overhead transmission line adjacent to the substation.

The magnetic field is 20 µT at 10m distance from the centreline of the overhead lines. The electric field is 2.3 kV/m at 10m from the centreline.

These levels are compliant with the ICNIRP guideline limits and the EU EMF Recommendation.

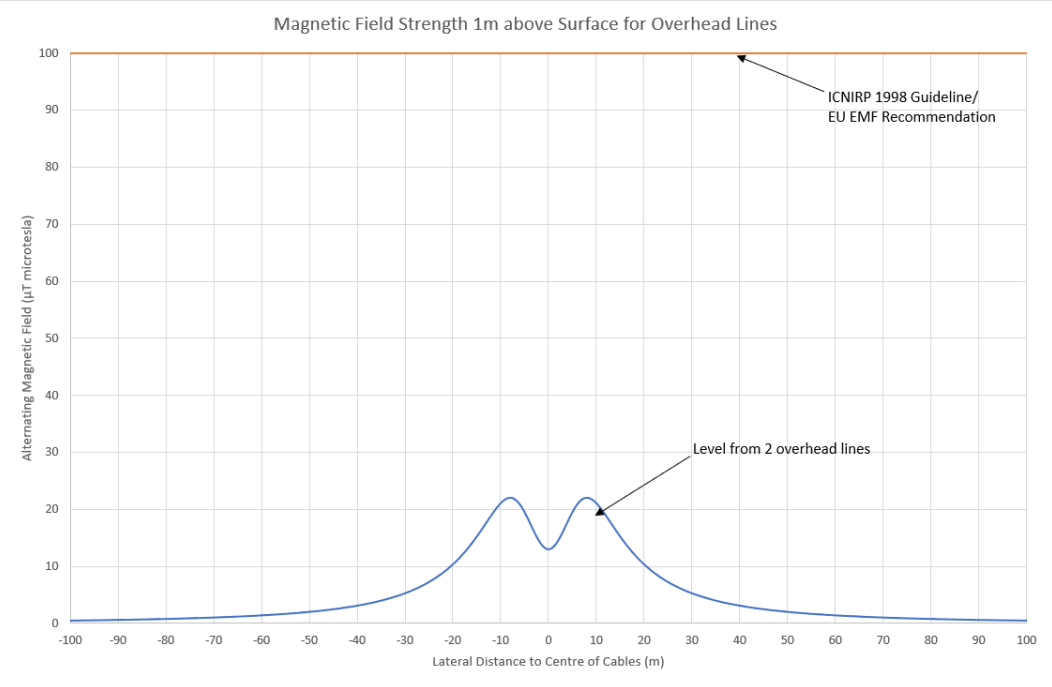


Figure 6: Magnetic Fields from Overhead Twin Circuit Line

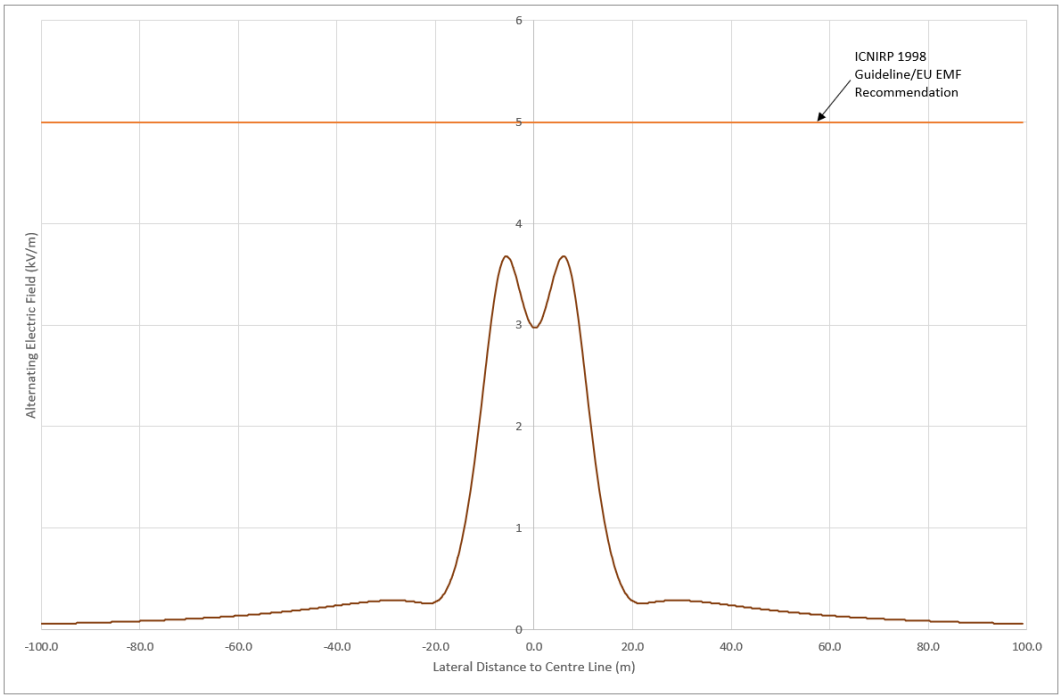


Figure 7: Electric Fields from Overhead Twin Circuit Line

Cumulative Impact Assessment

In addition to the new NETN connection, as part of the EirGrid upgrade works, EirGrid will consider stringing new conductors on the currently unused side of the 220kV towers, between the new 220kV loop-in transmission substation of this proposed development and the existing Arklow 220kV substation. This 220kV OHL circuit would either terminate in the existing Arklow 220kV substation or this circuit may be connected to an existing circuit at the Arklow 220kV substation and 'by-pass' the substation. There may be the need for an additional tower to bypass the Arklow 220kV substation with the new 220kV OHL circuit.

The double circuit line has been assessed based on a maximum load of 513 MVA on each side of the 220kV towers.

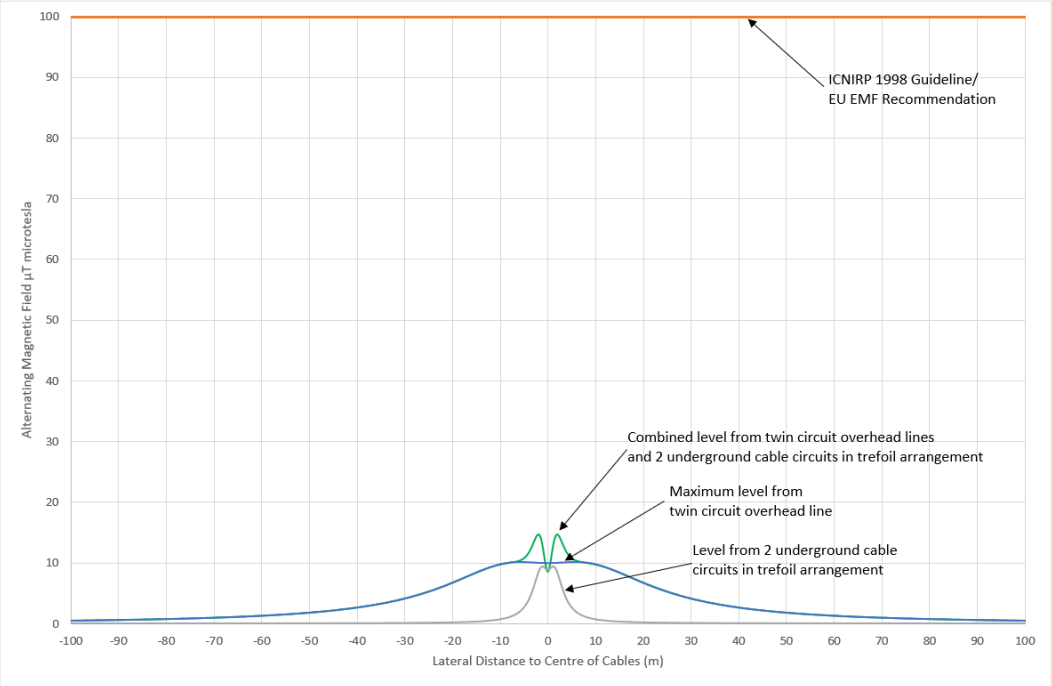


Figure 8: Combined Magnetic Fields from Overhead Twin Circuit Line and Underground Cable Circuits, Trefoil Arrangement

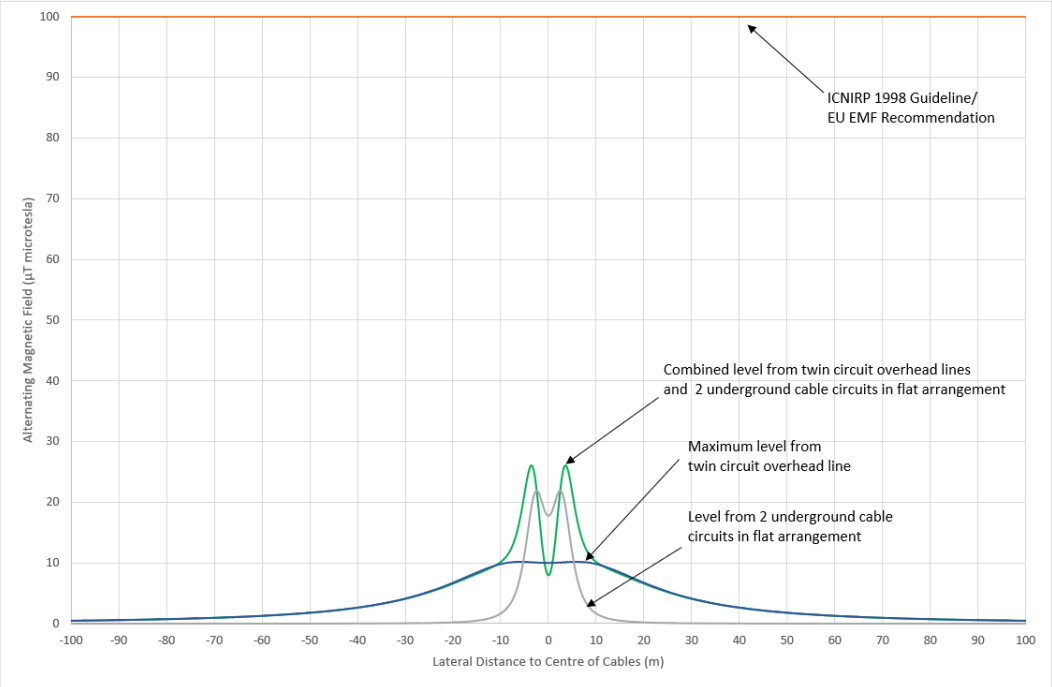


Figure 9: Combined Magnetic Fields from Overhead Twin Circuit Line and Underground Cable Circuits, Flat Arrangement

Figures 8 and **9** show the resultant magnetic field strengths from the combined overhead lines and underground cable circuits, assuming full load for all four circuits.

The underground cable circuits are proposed to cross the L2180 below the existing single circuit 220kV overhead line. The nearest dwelling to the existing line is at 20m distance.

The predicted magnetic field with all four circuits on full load is predicted to be 6.6 µT at 20m distance for trefoil arrangement and 6.7 µT for flat arrangement. These levels are below the ICNIRP guidelines.

With respect to interference levels, the contribution from the proposed development is negligible.

Mitigation and Enhancement Measures

As the impact on the EMF environment is acceptable as defined by the EU and ICNIRP guideline limits, no mitigation measures are proposed.

Interrelationship with other Impacts

There is no interrelationship between EMF and other environmental aspects.

Monitoring

No monitoring is proposed relating to EMF. The levels of EMF are substantially below the recognised guidelines and the need for monitoring is not foreseen.

Conclusion

There will be no significant impact from the proposed development from an EMF point of view on humans or animals as the development fully complies with the ICNIRP Guidelines (1998) and the EU EMF Recommendation 1999/519/EC. In addition, there will be no significant impact from the proposed development from an EMC point of view as the predicted levels are lower than equipment interference guidelines.

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Glossary

ELF	Extremely low frequency
EM	Electromagnetic
EMC	Electromagnetic compatibility
EMF	Electromagnetic fields
EMI	Electromagnetic Interference
ICNIRP	International Commission on Non-Ionising Radiation Protection
DC	Direct Current
AC	Alternating current
RFI	Radiofrequency
IARC	International Agency for Research on Cancer
WHO	World Health Organisation