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Environmental Report

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Title:	Impact Report for Greenlink HVDC Project

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Glossary of Terms

AC	Alternating current
DC	Direct current
Amps	Ampere (a unit of electrical current)
ELF	Extra Low Frequency
EMF	Electro-magnetic fields
EMR	Electromagnetic radiation
EMI	Electromagnetic interference
HVDC	High Voltage Direct Current

Human Health including Electromagnetic Field (EMF)

1. Introduction

In this section we consider the electromagnetic emissions from the proposed HVDC cable and possible effects on human health.

Throughout this section reference is made to a number of electromagnetic field (EMF) types including Extra Low Frequency electromagnetic fields (ELF-EMF), electromagnetic spectrum, electric and magnetic fields and alternating current (AC) fields, electromagnetic compatibility (EMC), electromagnetic radiation (EMR) and electromagnetic interference (EMI).

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. 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. EMR carries energy and momentum that may be imparted into matter with which it interacts.

The proposed power line will be a DC system which predominately generates static magnetic fields. There will be no electric fields generated as the metallic outer surface of the cable prevents electric fields.

The study area for this assessment includes a distance of 100 metres either side of the line.

2. Allowable Levels

Internationally the allowable levels of EMF are published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). The ICNIRP limits have been adopted by the European Commission for the public and occupational application. For occupational purposes a directive was published:

- Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)

For public application the EU published a Recommendation:

- Recommendation on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) 1999/519/EC;

The Irish government establishes expert groups from time to time to advise on EMF.

In Ireland government policy is set by the Department of Communications, Climate Action and Environment which continues to adopt the international guidelines developed by the ICNIRP and endorsed by the World Health Organisation (WHO) and the European Union.

In 2019 the government published a Statutory Instrument (S.I. No 190/2019) which assigns responsibility to the Environmental Protection Agency for providing advice to the Government and the public on exposure to electromagnetic fields. The EPA will also carry out independent monitoring of public exposures.

ICNIRP has issued guidelines for limiting the exposure to static and time varying electric and magnetic fields up to 300 GHz. ICNIRP frequently updates these guidelines. The latest updates on static fields are covered by:

- ICNIRP Guidelines on Limits of Exposure to Static Magnetic Fields Published in: Health Physics 2009

Note that the earth's magnetic field is between 30 micro Tesla and 70 micro Tesla (from equator to poles) and is a static field that is present everywhere on the earth. The level in Ireland is around 49 micro Tesla.

The 1998 ICNIRP limit for static magnetic fields, included in the EU Recommendation, is 40 milli Tesla (40,000 micro Tesla). In accordance with the EU Recommendation, this limit applies only where the time of exposure is significant.

The ICNIRP 2009 guidance advises a public limit of 400 milli Tesla. ICNIRP applies a reduction factor of 5 to the threshold at which adverse health effects occur to account for biological uncertainties.

In addition to the health limits outlined above, there are limits for electromagnetic compatibility (EMC) and potentially susceptible devices such as active implantable medical devices (AIMD). These include devices such as cardiac pacemakers, implanted defibrillators, cochlear implants and similar devices. The ICNIRP notes that these levels can be as low as 500 micro Tesla. The occupational EMF Directive 2013/35/EU states an action level of 500 micro Tesla for static magnetic fields reasoned by interference with the operation of AIMDs.

Table 1 – Public DC Exposure Guidelines

Source	Magnetic Flux Density (micro Tesla)
ICNIRP 1994	40,000
ICNIRP 2009	400,000
EU EMF Recommendation 1999/519/EC	40,000 500 suggested for pacemakers and similar

3. Predicted Levels from System

The static magnetic field produced by the cable has the same characteristics as the earth's magnetic field. Thus, exposure to electric and magnetic fields are common. Mankind has evolved in a magnetic field similar to that emitted by the cables.

3.1 Static Magnetic Field Strength

The magnetic field strength around a single cable can be calculated using:

$$B = \frac{\mu I}{2\pi r}$$

B : magnetic flux density in Tesla
μ : magnetic permeability of the material (1 for air, soil, water, humans)
I : current through the power cable in Amperes
r : distance between the power cable and the point of observation in meters.

The proposed system uses two cables, one is a positive conductor and the other is a negative return. The two cables carry equal currents flowing in opposite directions. The magnetic fields from these conductors circulate around the cable in opposite directions and largely cancel.

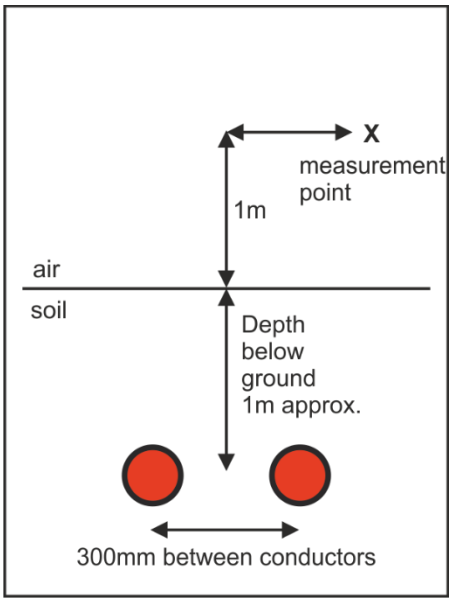

Figure 1: Cable Arrangement

The cables are located 300mm apart and approximately 0.9m below ground. The cables carry a maximum current of 1134 amps, +/- 320 kV.

Figures 2 and 3 show the modelled magnetic flux density levels at 100% load of 1134 amps and a typical load of 810 amps.

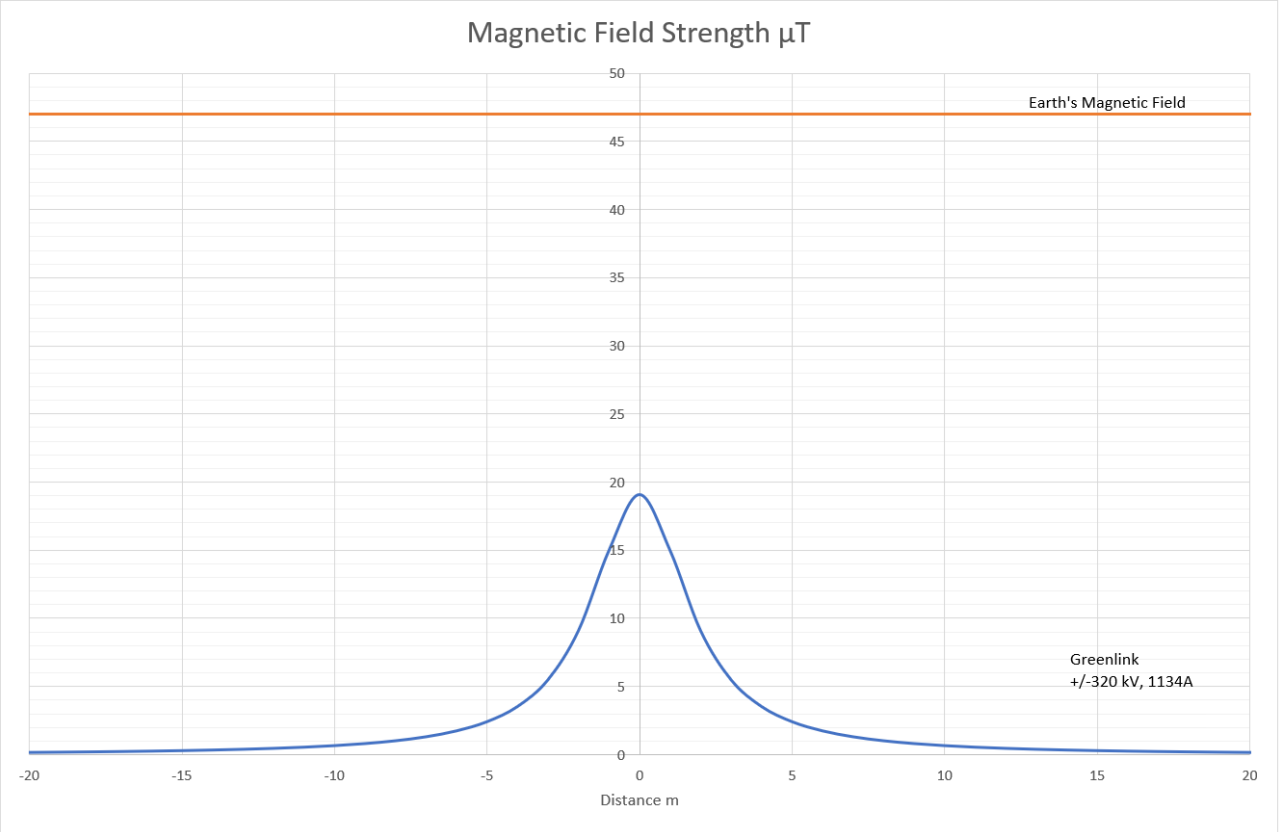

Figure 2: Magnetic Field Strength on 100% Load (1134 amps)

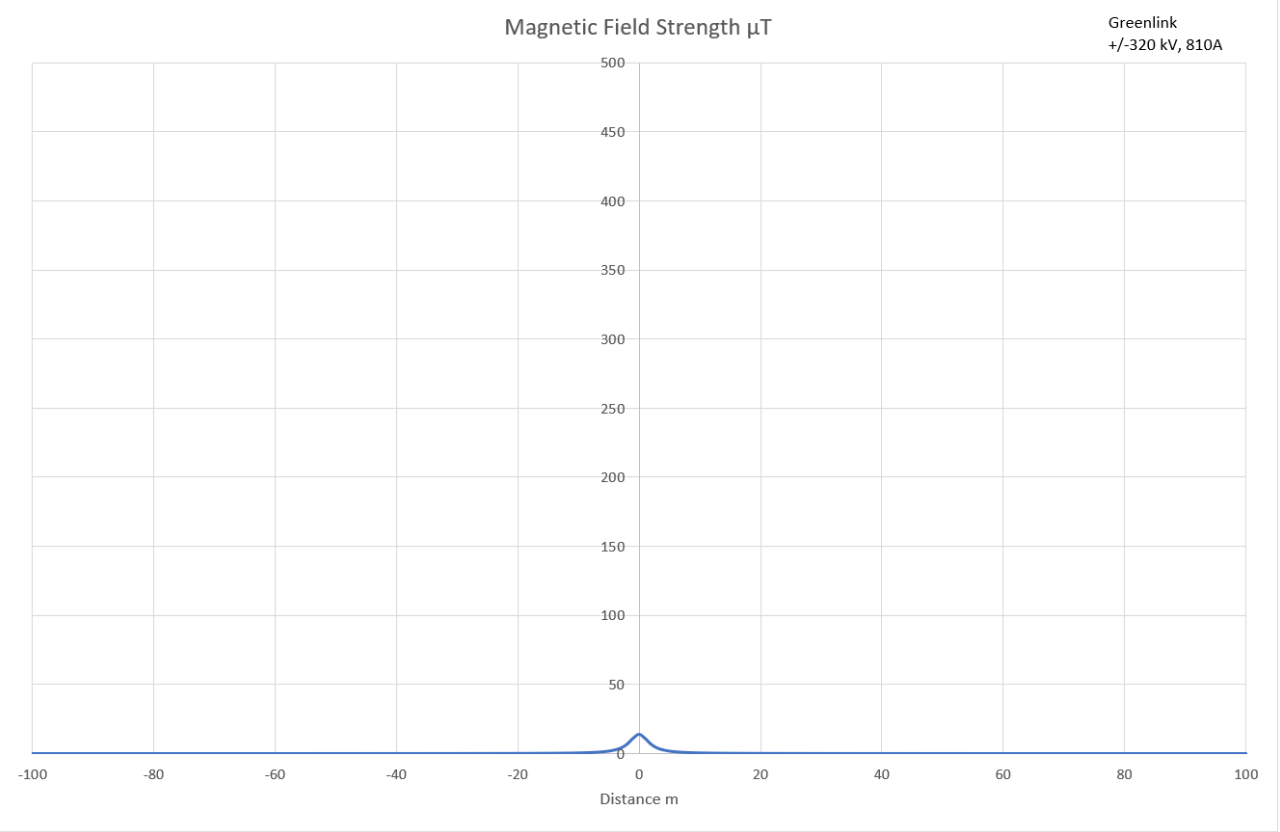

Figure 3: Magnetic Field Strength at 810 amps

Table 2 summarises the levels at various distances from the line.

Table 2 – Predicted EMF Values for Proposed Power Line

Location	Static Magnetic Flux Density (micro Tesla)
Peak Level (100% load)	19
1m (100% load)	15
25m (100% load)	0.11
50m (100% load)	0.028
100m (100% load)	0.007

Typically, the burial depth of the cables is 1 metre, the shallowest burial is approximately 0.9 meters. Houses and other buildings are typically several meters away. The closest house has a distance of 1 meters from the centre of the cable circuit.

Compared to the limits provided by ICNIRP, the static magnetic fields which can be expected on the surface level are well below. Furthermore, the magnetic flux density of 19 micro Tesla is also much lower than the value of 500 micro Tesla mentioned by ICNIRP as the restriction levels per IEC and CENELEC for people with implanted electronic / ferromagnetic medical devices. Note that the ICNIRP restriction level for people without implanted medical devices is 400,000 micro Tesla (400 milli Tesla).

Directly above the cable, on full load, the contribution to the magnetic field are predicted to be 19 micro Tesla. At 1m the level has decreased to 15 micro Tesla. As can be seen from the data above, the levels decrease very quickly with distance. As the existing earth's magnetic field is 49 micro Tesla the levels from the cable will not be significant. As the direction of the earth's magnetic field and the contribution from the cable are unlikely to exactly align the levels do not add. As a result the measured levels typically exhibit as change of direction of the existing magnetic as opposed to an increase in magnetic field. At distances of more than 1m the effect of the magnetic field from the power line will not be noticeable.

3.2 Time Varying Magnetic Field Limits

The magnetic field generated by the cable system is predominately DC, generating a static magnetic field similar to the earth's magnetic field as noted earlier.

The cable circuit will also generate low level time varying magnetic fields due to time varying currents superimposed on the DC current, called ripple which is a natural effect of the AC to DC conversion at the converter stations at each end. The time varying (AC) current component will generate low level AC fields. The levels of AC current and hence the AC emissions will be controlled by filtering at the converter stations. As a result, the AC magnetic field emissions from the cable will be negligible compared to the respective ICNIRP guideline limits.

4. Electromagnetic Compatibility

As the predicted DC magnetic emanating from the power line will be lower than the existing earth's magnetic field electromagnetic interference (EMI) would not be expected. In addition, any AC component will well below EMI levels.

5. Converter Station

The converter station comprises DC and AC systems and there will be electromagnetic fields close to the building. The converter station and surrounding equipment is designed to ensure that negligible electromagnetic fields would be produced outside the boundary fence.

The nature of the equipment in the converter station means that magnetic fields decrease rapidly with distance. Outside the boundary fence, they will be well below the exposure limits. The magnetic fields around the converter station would be produced by the AC and DC cables.

The converter station is assessed as having no adverse effects.

6. Conclusions

The predominant emission from the power line will be a DC, static, magnetic field.

The predicted magnetic fields generated by the power line can be considered to be very low compared to the ICNIRP guidelines and the European Union limits. The levels will be sufficiently below the existing earth's magnetic field as to not make a significant contribution to the overall magnetic field.

The magnetic field emissions will be negligible compared to the most stringent limit suggested by ICNIRP and European standards of 500 micro Tesla applicable to pacemakers and similar devices.

The maximum magnetic field emission, directly above the cable, of 19 micro Tesla, will be well below the earth's magnetic field of 49 micro Tesla. At 5 m the maximum level of 2.4 micro Tesla will be insignificant compared to the earth's magnetic field.

The AC levels from the cable will be controlled to ensure that they will be negligible compared to the relevant ICNIRP limits.

Based on the predictions of the magnetic flux density values there will be no impact on residential properties at any distance from the proposed alignment as the ICNIRP guidelines are not exceeded at all distances.

6.1 Residual Effects

There are no residual impacts associated with the proposed alignment.

6.2 Construction Phase

No impacts

7. References

ICNIRP Guidelines on Limits of Exposure to Static Magnetic Fields, 2009

European Commission Recommendation on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) 1999/519/EC;

Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)

International Commission on Non-Ionising Radiation Protection (ICNIRP) Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300GHz);