Springwell Solar Farm

Environmental Statement
Appendix 5.5 High-Level Electromagnetic Field Assessment

Volume 3

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

EN010149/APP/6.3
November 2024
Springwell Energyfarm Ltd

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Executive Summary

Report Purpose

Pager Power has assessed the potential impact of electromagnetic fields (EMF) generated by electrical equipment pertaining to the Proposed Development . The assessment considers[1] the underground power cables (400kV cabling), transformers, and substations.

Overall Conclusions

Levels of electromagnetic radiation from the underground cables are predicted to be below ICNIRP (International Commission on the Non-Ionizing Radiation Protection) reference levels for magnetic and electric fields. Overhead lines are not proposed as part of the Proposed Development.

Radiation from the transformers that form part of the Springwell Substation will be even less significant because the equipment will be housed in protective enclosures. The Springwell Substation transformers will be CE and/or UKCA marked, indicating that a product has been assessed by the manufacturer and deemed to meet European Union safety, health and environmental protection requirements. CE marking requirements were adopted and extended indefinitely in Great Britain until the UK left the EU in 2020. From 1 January 2021, the UKCA mark started to replace the CE mark for goods sold within Great Britain, and the CE mark has continued to be required for goods sold in Northern Ireland.

Standards in the UK

The UK Policy on public exposure limits to EMF radiation is designed to comply with the 1998 ICNIRP (International Commission on the Non-Ionizing Radiation Protection) guidelines in terms of the 1999 EU Recommendation. In 2010 ICNIRP produced new guidelines but these have not yet been incorporated into UK Policy. The public exposure limits in UK policy define reference levels for electric and magnetic fields. Where field levels exceed these reference levels in significantly occupied spaces, further investigation is warranted. Further information can be found in Sections 2 and 3 of this report.

Assessment Conclusions – 400kV Underground Cables

The recommended clearance buffer for proposed underground cables 400kV cables is 25m. At this distance, the magnetic field is predicted to be less than 1 micro-Tesla;

[1] The maximum voltages for underground cables, transformers/PV inverters and the distribution substation have been assumed to account for a worst-case scenario in the absence of a finalised electrical design of the site.

significantly lower than the threshold value of 100 micro-Tesla for public exposure limits in UK policy. Electric fields are not considered significant (Section 4.2.3). The 400kV route can only be built within the extent of Works Number 5 as outlined within the **Draft DCO [EN010149/APP/3.1]** and outlined in the **Works Plans [EN010149/APP/2.3]** which is approximately 500m from any sensitive receptors.

This value correlates to a human being 1m above ground, directly above the cable, and therefore the magnetic fields will be further diminished due to any separation distances horizontally from the cables to any dwelling.

Assessment Conclusions –Springwell Substation transformers

The most significant sources of radiation other than the underground cables are the Springwell Substation transformers.

The Springwell Substation transformers will be 'CE' marked (Conformité Européene, or European Conformity marking), and/or 'UKCA' marked (UK Conformity Assessed). CE and UKCA markings indicate that a product has been assessed by the manufacturer and determined to meet the safety, health, and environmental protection requirements of the European Union and the United Kingdom, respectively. CE marking requirements were adopted and extended indefinitely in Great Britain until the UK left the EU in 2020. From 1 January 2021, the UKCA mark started to replace the CE mark for goods sold within Great Britain, and the CE mark has continued to be required for goods sold in Northern Ireland.

The CE marking should ensure that electrical and electronic equipment does not generate, or is not unintentionally affected by, electromagnetic disturbance.

1. Proposed Development

1.1. Site Layout

1.1.1. A summary of the description of the Proposed Development can be found in Section 3.1 of the **Environmental Statement (ES) Volume 1, Chapter 3: Proposed Development Description [EN010149/APP/6.1]**. The layout of the Site, including the location of the Grid Infrastructure (400kV cables) and Springwell Substation are detailed in **ES Volume 2, Figure 3.1: Zonal Masterplan [EN010149/APP/6.2]** and secured in the **Works Plans [EN010149/APP/2.3].**

1.1.2. This assessment has been based on the worst case extent of the infrastructure as outlined in **ES Volume 2, Figure 3.1: Zonal Masterplan [EN010149/APP/6.2]** and secured in the **Works Plans [EN010149/APP/2.3]**.

1.1.3. This assessment considers the sensitive receptors in close proximity to the Site and the potential for electric and magnetic effects.

1.1.4. From a review of Natural England's online data mapping sources, it indicates that there are no Sites of Special Scientific Interest (SSSI), Special Protection Areas (SPA)**,** Ramsar sites or Special Areas of Conservation (SAC) adjacent to or at closer distance than the residential locations assessed within this report (refer to **ES Volume 1, Chapter 7: Biodiversity [EN010149/APP/6.1]** for further detail).

1.2. Electrical Infrastructure

1.2.1. The Proposed Development will comprise of up to two 400kV cable circuits buried underground which will be located within the siting zone for the Grid Connection Corridor as illustrated in **ES Volume 2, Figure 3.1: Zonal Masterplan [EN010149/APP/6.2]**. The maximum cable trench would be up to 2m in width and up to a depth of 1.5m.

1.2.2. The Proposed Development does not propose any overhead lines. The proposed infrastructure of underground cables will link into the proposed National Grid Navenby Substation. The network of existing overhead lines is outlined in **ES Volume 2, Figure 2.1: Environmental Considerations [EN010149/APP/6.2]**.

2. Technical Background

2.1. Overview

2.1.1. All electrical equipment emits electric and magnetic radiation. Power cables produce both electric and magnetic fields which can potentially affect human health.

2.1.2. Radiation from underground cables is generally less than radiation from overhead lines because emissions from adjacent conductors within a cable tend to cancel each other out. When assessing the impacts of overhead powerlines, it is important to consider the impact of both electric and magnetic fields.

2.1.3. Underground cables generally cause a negligible electric field above ground but can cause a significant magnetic field which is dependent on the current in the conductors.

2.2. Electromagnetism

2.2.1. The movement of electric charge causes electric and magnetic fields to be produced in the space surrounding the charge. Human exposure to such fields can cause health problems if persistent and/or they are of high strength. The magnitude of the effects is dependent on both the field strength and the exposure time.

2.3. Health Concerns – Potential Effects

2.3.1. The potential effects on human health caused by time-varying magnetic fields, such as those generated by alternating current (AC) cables, are due to induced current on functions of the central nervous system. There are various international bodies which provide maximum safe exposure levels to time varying electromagnetic fields.

2.3.2. Various sources of information relating to safe exposure levels have been reviewed as part of this study.

2.3.3. The UK Policy on public exposure limits to EMF radiation is designed to comply with the 1998 ICNIRP (International Commission on the Non-Ionizing Radiation Protection) guidelines in terms of the 1999 EU Recommendation. In 2010 ICNIRP produced new guidelines but these have not yet been incorporated into UK Policy. The public exposure limits in UK policy define reference levels for electric and magnetic fields. Where field levels exceed these reference levels in significantly occupied spaces, further investigation is warranted.

2.3.4. Another relevant resource consulted is the *EMFs.info* webpage, where the UK electricity industry have collected the relevant studies pertaining to safe limits on exposure (presented in **Section 3**).

2.4. Radiation from Home Electrical Equipment

2.4.1. The World Health Organization (WHO) have published data regarding electromagnetic fields including the following typical levels for home electrical equipment, shown in **Table 1** below.

Appliance	Electric field strength (Volts per metre)	Magnetic field strength (micro-Tesla) (at 1 metre)
Hair Dryer	80	0.01 – 7
Iron	120	0.12 – 0.3
Vacuum Cleaner	50	2 – 20
Refrigerator	120	0.01 – 0.25
Television	60	0.04 - 2

Table 1: Typical emissions from home electrical equipment

2.5. Radiation Reduction with Distance

2.5.1. Radiation levels reduce with distance; for example, the typical magnetic field from a vacuum cleaner reduces from 800 micro-Tesla to 2 micro-Tesla when the separation distance increases from 3 centimetres to 100 centimetres.

2.5.2. This means radiation levels from the infrastructure, including the cabling and Springwell Substation will tend to reduce with distance in any direction – including towards a receptor.

3. Reference Limits for Electromagnetic Fields

3.1. Exposure Limits in the UK

3.1.1. As set out in the previous section, the limits in the UK come from the 1998 ICNIRP guidelines. The original guidance in 1999 specified:

i) Basic Restrictions;
These are the levels at which radiation is potentially harmful to humans. This is a current density[2] given in mA m^{-2} (milliamps per metre squared)

ii) Reference Level (Investigation Level);
Provided for practical exposure assessment purposes to determine whether the basic restrictions are likely to be exceeded. Compliance with the reference level will ensure compliance with the relevant basic restriction;

iii) Field Actually Required
This is the field strength at which the basic restriction is likely to be exceeded.

3.1.2. The values for the above stated in the ICNIRP 1998 paper are shown in **Table 2** below. These are the public exposure values, not the occupational exposure values – the former is more conservative than the latter by a factor of five. The data presented in **Table 2** below have been referenced to within the technical assessment.

Basic Restriction (mA m^{-2})	Magnetic Fields Reference Level (μT)	Electric Fields Reference Level (kV m^{-1})	Magnetic Field Actually Required (μT)	Electric Field Actually Required (kV m^{-1})
2	100	5	360	9

Table 2: ICNIRP Exposure Limits 1998

[2] Current density is the amount of electric current flowing through a unit area.

3.2. Height Above Ground Used for Testing Compliance

3.2.1. EMFS.info specifically states[3] the following with regard to the height to be used to test compliance:

'The standard height for measuring fields, especially from power lines, is 1 m above ground level ... This isn't just because it's a convenient round number, it's because roughly half way up the height of a standing person is actually the height that gives the best approximation to the induced current in the body.'

3.3. Safe Levels – Summary

3.3.1. The values of interest are those shown in **Table 2** above. Effectively, this means that in locations of significant exposure time, such as residences, levels should be below:

- 100µT (magnetic fields);
- 5kV m^{-1} (electric fields).

3.3.2. Values exceeding the limits above, at one metre above ground level, would suggest that further investigation is required.

[3] Last accessed June 2024

4. Technical Assessment

4.1. Overview

4.1.1. Data from various cable configurations have been sourced from EMFS.info. Maximum field data has been used where possible to provide a more conservative assessment.

4.1.2. The Nationally Significant Infrastructure Projects: Technical Advice Page for Scoping Solar Development states:

'*Where proposed cables are over 132kV, an EMF assessment should be provided in an appendix to the Environmental Statement. This should include the location, routing and voltages of any cables over 132kV and a risk assessment to any human and ecological sensitive receptors within the ZoI*.'

4.1.3. **Figure 1** below shows the magnetic fields for 132kV overground lines and underground cables relative to distance, which represents the cables that will be across the Site to connect the Solar PV development to the BESS and Springwell Substation.

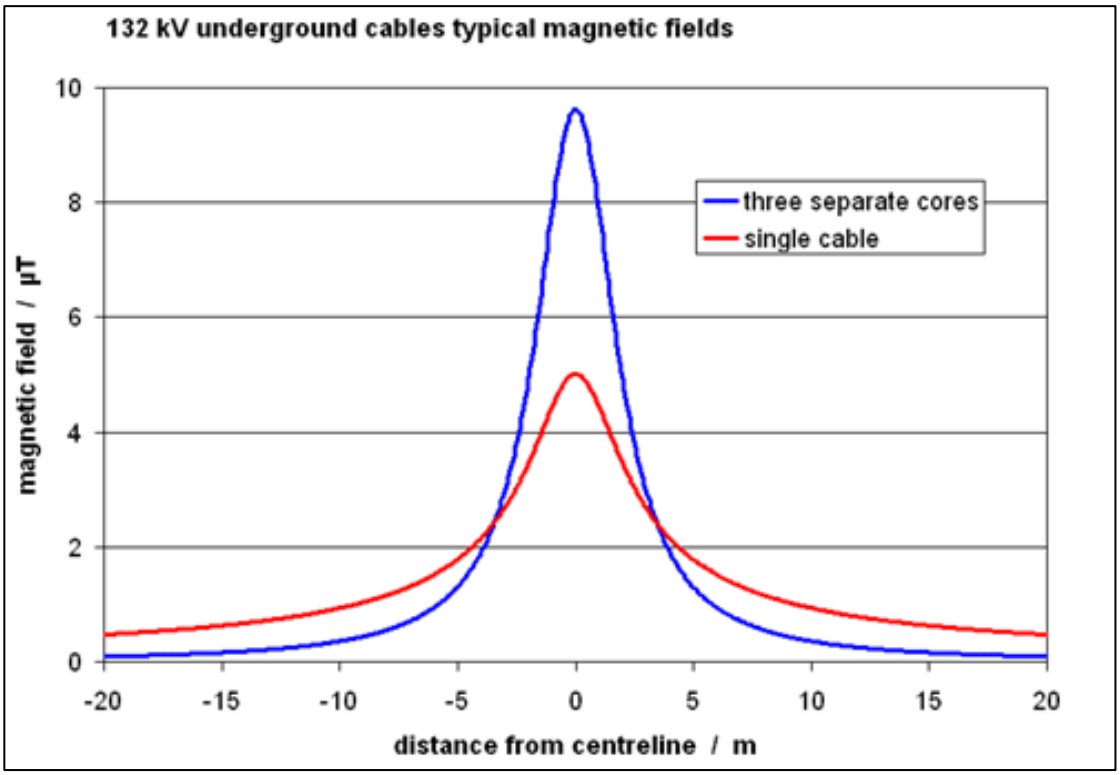

Figure 1: Typical magnetic fields associated with 132kV underground cables (Source: EMFS.info [March 2024])

4.1.4. The maximum magnetic field (10 µT) for 132kV underground cables is significantly lower than the reference exposure limit of 100 µT. Therefore, no further assessment of the 132kV infrastructure is required. Further analysis of infrastructure greater than this is presented in the following subsections. No ecological sensitive receptors have been identified relative to the electrical infrastructure of the Proposed Development. No significant impacts are therefore predicted upon ecological sensitive receptors.

4.2. Underground Cables

Magnetic Fields

4.2.1. Figure 2 below shows the magnetic fields for 400kV overground lines and underground cables relative to distance, which represents the maximum assumed voltage for underground cables for the Proposed Development.

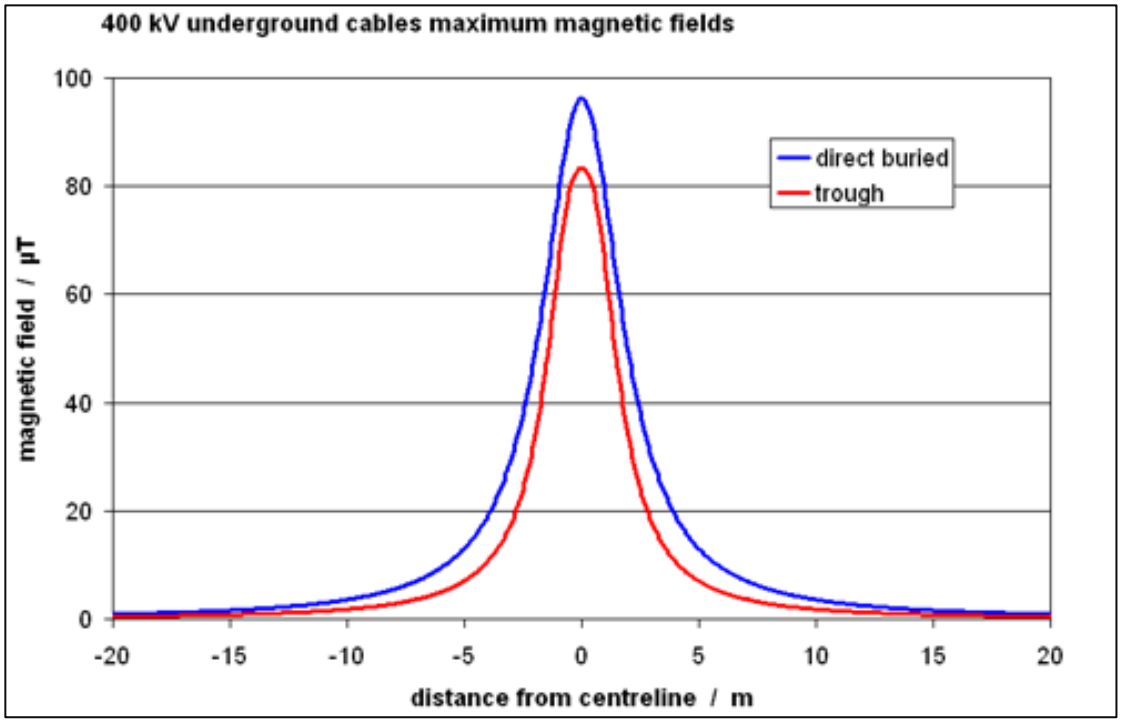

Figure 2: Typical magnetic fields associated with 400kV underground cables (Source: EMFS.info [March 2024])

4.2.2. The maximum magnetic field at 1m above ground, directly above the centreline, for an underground cable measures 95 micro-Tesla; lower than the threshold of 100 micro-Tesla to be a significant level to human exposure. The magnetic field for underground cables diminishes rapidly in a short distance, reaching approximately 0 micro-Tesla within 20m from the cable centre line.

Electric Fields

4.2.3. EMFS.info states[4]:

'Electric fields from underground cables are contained within the cable's protective insulation and sheath, so there are no external electric fields.'

4.2.4. Therefore, no electric field pertaining to the underground cables for 132kV and 400kV cables for the Proposed Development is considered significant.

4.3. Springwell Substation transformers

4.3.1. The most significant sources of radiation other than the underground cables are the Springwell Substation transformers. The Springwell Substation would include up to seven transformers.

4.3.2. The Springwell Substation transformers would be CE marked (Conformité Européene, or European Conformity marking), and/or 'UKCA' marked (UK Conformity Assessed). CE and UKCA marking indicates that a product has been assessed by the manufacturer and deemed to meet the safety, health and environmental protection requirements of the European Union and the United Kingdom , respectively. CE marking requirements have been adopted and extended indefinitely in Great Britain until the UK left the EU in 2020. From 1 January 2021, the UKCA mark started to replace the CE mark for goods sold within Great Britain, and the CE mark has continued to be required for goods sold in Northern Ireland. This will be confirmed prior to installation.

4.3.3. In this case, the relevant EU Directive for CE marking is[5] Electromagnetic Compatibility Directive 2014/30/EU, which should ensure that electrical and electronic equipment should not generate, or be affected by, electromagnetic disturbance.

4.3.4. The relevant EU Directive for CE marking is[6] Electromagnetic Compatibility Directive 2014/30/EU, and the relevant UK Statutory guidance for UKCA marking is the Electromagnetic Compatibility Regulations 2016[7]. This legislation should ensure that electrical and electronic equipment should not generate, or be affected by, electromagnetic disturbance.

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[4] Source: emfs.info 'https://www.emfs.info/electricity-system-and-sources/cables#:~:text=Underground%20cables%20produce%20EMFs%20in,are%20no%20external%20electric%20fields.

[5] Source: [redacted]

[7] Source: https://www.gov.uk/government/publications/electromagnetic-compatibility-regulations-2016/electromagnetic-compatibility-regulations-2016-great-britain

4.3.5. The Springwell Substation transformers are understood to be of industry standard and will therefore abide to the Electromagnetic Compatibility (EMC) standards and the conformity as outlined above (4.3.2). Therefore, no significant electrical fields from the Springwell Substation transformers are predicted.

4.4. Comparative Assessment

Magnetic Fields

4.4.1. The maximum magnetic field produced by appliances such as vacuum cleaners can reach up to 20 micro-Tesla. It would follow that appliances with larger voltages would produce fields at a higher level; however, the 400kV underground cables do not produce significantly larger fields and are within the acceptable exposure limits.

4.4.2. The Springwell Substation transformers will produce magnetic fields at levels lower than the underground cables, thus lower than or comparable to the household appliances previously mentioned.

Electric Fields

4.4.3. The maximum electric field produced by larger household appliances such as refrigerators is 0.12kV m^{-1}. Existing safety measures mitigate exposure to these fields, ensuring acceptable exposure limits.

4.5. Recommended Minimum Clearance Distances

4.5.1. The recommended minimum clearance distances relative to the public exposure limits for magnetic and electric fields considered in this report is 25m. The estimated maximum magnetic field at this distance will be less than 1 micro-Tesla and within the acceptable exposure limits.

4.5.2. The Proposed Development is not expected to require a buffer due to electric fields, as per section 4.2.3.

4.5.3. The 400kV route can only be built within the extent of Works Number 5 as outlined within the **Draft DCO [EN010149/APP/3.1]** and outlined in the **Works Plans [EN010149/APP/2.3]** which is approximately 500m from any sensitive receptors.

4.6. Cumulative Effects

4.6.1. When assessing the cumulative effects of electromagnetic fields, the worst case is based upon the addition of source a and source b; however, it is important to note that this is only true for magnetic fields that are exactly in line. When the electromagnetic fields are not in line, the sum of these is less than ‘a+b’.

4.6.2. The typical electromagnetic fields for infrastructure associated with the Proposed Development is shown to be within and below the acceptable exposure limits. The cumulative effects are not significantly impacted by the use of household items. Electrical household appliances will add to the overall exposure of electromagnetic fields; however, these levels should remain below the recommended exposure limit, due to the lower voltages of the appliances, and are not used constantly, providing only a temporary addition to the resultant electromagnetic field levels.

4.6.3. Considering all sources of radiation, the cumulative magnetic and electric fields are predicted to be significantly below the acceptable exposure limits.

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