The Impact of EMF on Marine Life, Flora and Fauna, and BioDiversity in the West Burton Solar Project.

1. Written Representation (WR) on Electromagnetic Fields (EMF)

The developer, West Burton Solar Project, has not made any consideration of the impact of Electro Magnetic Fields (EMF) on:

- Marine Life.
- Flora and Fauna.
- Biodiversity

Introduction

The Project of ground mounted solar panels, generating station with a gross electrical output capacity of over 50 megawatts and over 20Km of electrical cabling.

Cabling between transformers and the switchgear and from switchgear to the onsite substation will be a minimum of 0.4m deep and 0.4m wide or a trenchless technique will be used. Suspended cables will be suspended between 0.4m to 2.4m above ground level.

Watercourse Cable Crossing Locations, in which there will be 31 watercourse crossings, including the Rivers Trent and Till and their tributaries. The river crossings will be subject to temporary horizontal directional drilling pits.

These crossing will make provision for additional and possible future cabling from Gate Burton, West Burton, and Tillbridge and Solar Farm projects. Where set in horizontal directional drilling sections, the maximum bore of a single drilled cable tunnel is 1.0m

The mighty River Trent, whose 271km long journey begins near Stoke-on-Trent and ends in the sea at the Humber Estuary is special and is one of the UKs most important rivers. Its catchment helps feed the nation, nourishes the communities that live on its banks and supports a huge diversity of natural habitats that need both our protection and help with recovery and reconnection.

Our rivers and freshwater habitats are polluted because of human activities including how we treat water and the ways in which we manage land. We are facing an ecological emergency with 15% of all UK wildlife under threat from extinction and our rivers are a critical factor in this.

Ambient levels of nonionizing electromagnetic fields (EMF) have risen sharply in the last five decades to become a ubiquitous, continuous, biologically active environmental pollutant, even in rural and remote areas.

Many species of flora and fauna, because of unique physiologies and habitats, are sensitive to exogenous EMF in ways that surpass human reactivity. This can lead to complex endogenous reactions that are highly variable, largely unseen, and a possible contributing factor in species extinctions, sometimes localized.

Numerous studies across all frequencies and taxa indicate that current low-level anthropogenic EMF can have myriad adverse and synergistic effects, including on orientation and migration, food finding, reproduction, mating, nest and den building, territorial maintenance and defence, and on vitality, longevity and survivorship itself.

Since the 1960s, scientists have discovered that variations in the resonances correspond to seasonal changes in solar activity, the Earth's magnetic environment, in atmospheric water aerosols and various other earth-bound phenomena, including increased weather activity due to climate change.

Many species rely on the Earth's natural fields for daily movement, seasonal migration, reproduction, food-finding, and territorial location, as well as diurnal and nocturnal activities. Most harmful radiation coming from outer space is blocked by the Earth's magnetosphere.

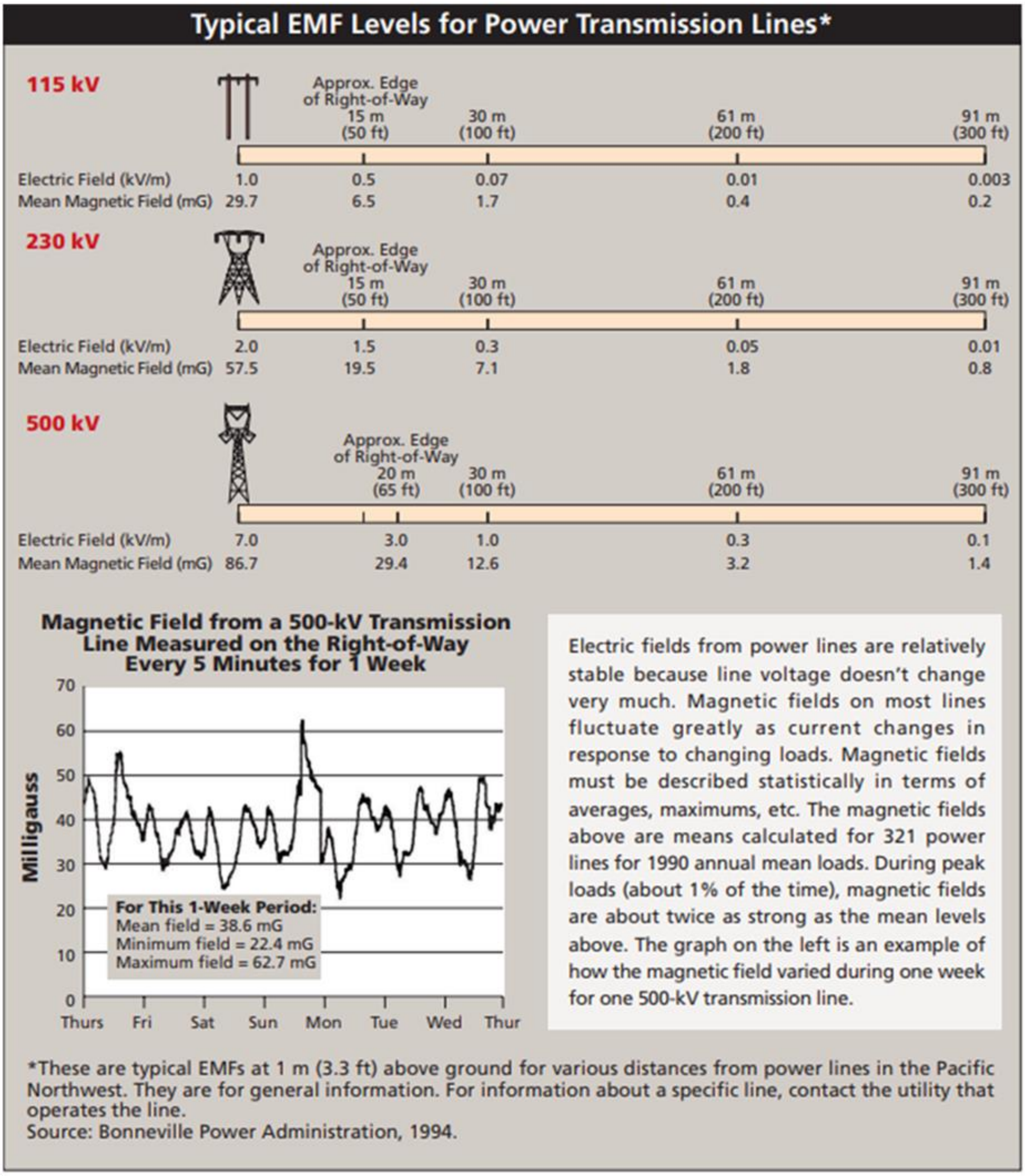
And although "natural," not all energy is alike. Man-made exposures contain propagation characteristics — such as alternating current, modulation, complex signalling characteristics (e.g., pulsed, digital, and phased array), unusual wave forms (e.g., square and sawtooth shapes), and at heightened power intensities at the Earth's surface that simply do not exist in nature.

These are all man-made artifacts.

Almost 4,971 mi (8,000 km) of high voltage direct current (HVDC) cables were present on the seabed worldwide, 70% of which were in European waters, and this is only expected to grow dramatically as new sources of renewable energy are built to replace fossil fuels globally.

The developer has identified a myriad of cable runs in the project resulting in connections carrying up to 400Kv to transport electricity from the solar panels to the National Grid at Cottam Power Station using transformers, inverters etc.

Conventional overhead power lines of this size, linked to the National Grid must have a clearance height of at least 7 metres.



The cable carrying power lines at ground level in the project of 400Kv will have a greater effect on Electromagnetic Fields than if they were 7 metres above ground level. The magnetic fields will be significantly stronger, and the effect of EMF will be distanced further away by at least 7 metres.

For example, a magnetic field measuring 57.5 milligauss immediately beside a 230 kilovolt transmission line measures just 7.1 milligauss at 100 feet, and 1.8 milligauss at a distance of 200 feet, according to the World Health Organization in 2010.

The possible cumulative effect from future cabling of the Gate Burton, West Burton, and Tillbridge and Solar Farm projects will impact the consideration of EMF.

2. Written Representation (WR) on Marine Life.

The oceans, seas and rivers with their inhabitants are extremely important for the survival of us humans. The oceans regulate the climate of the planet and produce most of the oxygen. Millions of people depend on a healthy marine ecosystem for their livelihoods. What happens when, through our ill-considered and selfish intervention, the oceans can no longer maintain their vital functions for the entire planet?

There have been extensive EMF wildlife reviews published between 2003 and 2021 (10–22). Recently, Levitt et al. (23–25) extrapolated to broad ecosystem level effects for the first time, including extensive tables that match rising ambient levels to effects seen at vanishingly low intensities now common in the environment as chronic exposures.

The impact of EMF on Marine Life, especially when the power lines cross watercourses will be considered below:
Static- and ELF-EMF probably play important roles in the evolution of living organisms. They are clues used in many critical survival functions, such as foraging, migration, and reproduction. Living organisms can detect and respond immediately to low environmental levels of these fields.

There are two types of anthropogenic exposures created by cables: high voltage direct current (HVDC) that emits static magnetic fields, and three-phase alternating current (AC power transmission) that emit time-varying electromagnetic fields.

There is enough evidence to indicate we may be damaging non-human species at ecosystem and biosphere levels across all taxa from rising background levels of anthropogenic non-ionizing electromagnetic fields (EMF) from 0 Hz to 300 GHz.

Contrary to popular opinion, we know a great deal about how non-ionizing electromagnetic fields (EMF) affect non-human species because we have been using animal and plant models in research going back at least to the 1930's (1).

Effects have been seen in all taxa, in various frequencies, intensities, and exposure parameters. To non-human species, these are highly biologically active exposures, often functioning as stressors. This includes non-ionizing EMF in the static, extremely low frequency (ELF; 0–300 Hz) through the radiofrequency (RF) ranges used in all modern technology between 3 kHz and 300 GHz.

In addition, there have been extensive EMF wildlife reviews published between 2003 and 2021 (10–22). Recently, Levitt et al. (23–25) extrapolated to broad ecosystem level effects for the first time, including extensive tables that match rising ambient levels to effects seen at vanishingly low intensities now common in the environment as chronic exposures.

There are two prevalent misconceptions today about how low-level non-ionizing EMF couples with and affects non-human species:
(1) There is no need for environmental concern since exposures as currently regulated are too low to cause effects; and
(2) Existing exposure standards for humans are sufficient to cover non-human species too.
Neither supposition is accurate.

ICNIRP/IEEE/FCC have guideline components for both emissions (expressed as a value of radiant energy in space for far-field encounters at some distance from the generating source) and exposures [expressed as a specific absorption rate (SAR).

There are many things in the environment that can affect how non-ionizing electromagnetic energy is absorbed, including atmospheric moisture and/or particulate content, soil composition, natural and/or artificial obstacles (trees/buildings), and the presence of other waveforms which can augment and/or diminish exposures, among others.

For instance, many species can sense natural DC magnetic fields in diverse ways including migratory bird species (38, 39); numerous insect species including honey bees (40, 41); fish (42–47); mammals (48); bats (49); molluscs (50), and bacteria (51, 52). Some bird species may actually ‘see' the Earth's magnetic fields via complex magnetoception capabilities (53) located in their eye and beak areas

Many animals have evolved other special receptor organs. This unique ability allows electric fish to distinguish subtle differences in electrical properties within its immediate vicinity, including the electric fields of other fish, via electroreceptors capable of detecting a field of 5 nV/cm. While such evolutionary perceptual adaptations are extremely efficient and sensitive, they also render such species exceptionally vulnerable to unnatural anthropogenic fields.

The primary concern for aquatic species is from AC-ELF exposures from underwater cabling and other technologies, not RF which is of more concern for ground-based and aerial species (24).

The magneto mechanical model involves the naturally occurring iron-based crystal called magnetite (78–80) that has been found in most species studied, often in very different physiological areas.

Magnetite is highly reactive to external electromagnetic fields—a million times more strongly than any other known magnetic material. The abdominal areas of honey bees, for instance, contain magnetite with complex nerve endings feeding into it and can detect static magnetic field fluctuations as weak as 26 nT against background earth-strength magnetic fields that are much higher (79). They can also sense weak alternating fields at frequencies of 10 and 60 Hz (79). Bees are also affected by RFR.

Radiofrequency radiation may also affect natural “natal homing behaviour”—the astounding ability of some species like sea turtles (90); eels (91); and salmon (42–44), among others—to return to their original birth location to reproduce. The underlying mechanism, though imperfectly understood, involves such species being “imprinted” with the exact location of their birth, likely through geomagnetic configurations, then “remembering” it at reproduction time even when thousands of kilometres away.

There are at least 48 papers showing DNA damage after exposure to RFR at < 0.4 W/kg [see Supplement 1 in reference (24)]. Genotoxic effects are also seen in animal and plant species that are found exceptionally sensitive to both natural and man-made EMF [also see Supplement 2 in reference (24)]. Insects are of special concern as populations are being decimated globally (24).

Salmon had completely disappeared from the Trent River system by about the mid-1930s. where previously the River Trent and its tributaries historically sustained a native population of many thousands of salmon, with net fisheries reporting catches from the River Trent of around 3000 fish.

This has been achieved by the introduction of about 150,000 young salmon to the River Dove each year since 1998. This program has resulted in the first observation for 70 years of returning breeding adult fish in the River Trent.

The Trent Rivers Trust (TRT) is the lead organization for salmon in Nottinghamshire. Current Legislation affecting salmon includes the following: Atlantic Salmon are protected under the Salmon and Freshwater Fisheries Act 1975, supplemented by the Salmon Act 1986, and the species is listed under the EC Habitats Directive Annex 11a.

The Water Framework Directive and its work identifies amongst other species the European eel/elvers that is on the IUCN Red List, and on the OSPAR list of threatened and/or declining species and habitats and protected under the European Eel Regulation (European Commission) No 1100/2007 and the Eels (England and Wales) Regulations 2009.

3. Written Representation (WR) on Flora and Fauna.

There is enough evidence to indicate we may be damaging species at ecosystem and biosphere levels across all taxa from rising background levels of anthropogenic non-ionizing electromagnetic fields (EMF) from 0 Hz to 300 GHz leaving wildlife unprotected.

The literature is voluminous on EMF effects to nonhuman species, going back at least to the 1930s using modern methods of inquiry. We have, after all, been using animal, plant, and microbial models in experiments for decades.

There is no question that the huge diversity of pollinator species across the planet is suffering and that losses could be catastrophic with an estimated 90% of wild plants and 30% of world crops in jeopardy. There is a likelihood that rising EMF background levels play a role. Bees have been known for decades to have an astute sense of the Earth's DC magnetic fields, and rely on that perception for survival. For centuries beekeepers had noticed curious movements in beehives but Austrian ethologist Karl von Frisch finally interpreted that activity in the 1940s, winning the Nobel Prize in 1973 for what came to be known as the honey bee "waggle dance." Through complex circles and waggle patterns, bees communicate the location of food sources to other members of the hive, using the orientation of the sun and the Earth's magnetic fields as a gravity vector, "dancing" out a map for hive members to follow like nature's own imbedded GPS. Bees also detect the sun's direction through polarized light and on overcast days use the Earth's magnetic fields, likely through the presence of magnetite in their abdominal area and employ complex associative learning and memory.

Flowers, on the other hand, which are electrically grounded through their root systems, tend to have a negative charge in their petals created by surrounding air that carries around 100 V for every meter above ground. The accumulating positive charge around the flower induces a negative charge in its petals which then interacts with the positive charge in bees.

Trees also give us an answer. As a good electrical conductor (iv), a tree reacts sensitively to electromagnetic interference fields. Trees under radiation stress lose their leaves, starting with the brown colouration at the leaf ends (v). On the one hand, this could be due to a disturbed metabolism in or on the cell (vi), as has already been shown in animal cells under exposure to microwave radiation (vii). On the other hand, the brown colouration and withering of the leaves could also indicate a disturbed water balance. Water is very sensitive to electromagnetic radiation because it itself has an electromagnetic momentum.

Many species of flora and fauna, because of unique physiologies and habitats, are sensitive to exogenous EMF in ways that surpass human reactivity. This can lead to complex endogenous reactions that are highly variable, largely unseen, and a possible contributing factor in species extinctions.

Taken as a whole, this indicates enough information to raise concerns about ambient exposures to nonionizing radiation at ecosystem levels.

Wildlife loss is often unseen and undocumented until tipping points are reached. It is time to recognize ambient EMF as a novel form of pollution and develop rules at regulatory agencies that designate air as 'habitat' so EMF can be regulated like other pollutants.

Many species rely on the Earth's natural fields for daily movement, seasonal migration, reproduction, food-finding, and territorial location, as well as diurnal and nocturnal activities. Most harmful radiation coming from outer space is blocked by the Earth's magnetosphere.

What does need to be recognised is that:
The cable carrying power lines at ground level in the project of 400Kv will have a greater effect on Electromagnetic Fields than if they were 7 metres above ground level.

The magnetic fields created on the development site will be significantly stronger, and the effect of EMF will be distanced further away by at least 7 metres.

For example, a magnetic field measuring 57.5 milligauss immediately beside a 230 kilovolt transmission line measures just 7.1 milligauss at 100 feet, and 1.8 milligauss at a distance of 200 feet, according to the World Health Organization in 2010.

4. Written Representation (WR) on BioDiversity.

Mice and rats have been the primary animal species used in research, but also rabbits, dogs, cats, chickens, pigs, non-human primates, amphibians, insects, nematodes, various microbes, yeast cells, plants, and others. Effects have been seen in all taxa, in various frequencies, intensities, and exposure parameters. To non-human species, these are highly biologically active exposures, often functioning as stressors. This includes non-ionizing EMF in the static, extremely low frequency (ELF; 0–300 Hz) through the radiofrequency (RF) ranges used in all modern technology between 3 kHz and 300 GHz.

There has been an unprecedented rate of biodiversity decline in recent decades according to the International Union for Conservation of Nature which maintains a "Red List of Threatened Species" that is considered the world's most comprehensive source on the global conservation status of animal, fungi and plant species — all critical indicators of planetary health.
IUCN's 2018 list showed that 26,000 species are threatened with extinction, which reflected more than 27% of all species assessed. This was greatly increased from their 2004report that found at least 15 species had already gone extinct between 1984 and 2004, and another 12 survived only in captivity.

Genetic effects and EMF effects on insects.
Despite classic assumptions that non-ionizing radiation cannot directly damage DNA, genotoxic effects have been seen in land-based, aerial, aquatic, and plant species at very low intensity RFR exposures far below ICNIRP/IEEE/FCC guidelines. There are at least 48 papers showing DNA damage after exposure to RFR at < 0.4 W/kg [see Supplement 1 in reference (24)].

Insects are of special concern as populations are being decimated globally (24).

Depending on insect type and exposure duration, Michaelson and Lin (1) back in 1987 noted sequential insect reactions to RFR (at high intensities): insects first tried to escape, followed by motor disturbance and coordination problems, including stiffening, immobility, rigidity, and eventually death.

Ants also react adversely to RFR (109–111). Cammaerts et al. (111) found that memory and association between food sites and visual/olfactory cues in ants (Myrmica sabuleti) was significantly inhibited, with memory eventually wiped out altogether, from exposures to GSM-900 MHz signal at 0.0795 μW/cm2.
Affected insect groups included niche specialist species, as well as common and generalist species, many of which are critically important for pollination, as well as seed, fruit, nut and honey production, and natural pest control, among others of immeasurable economic and ecological value.

Environmental EMF should be added to this list since many insects and other living species have sensitive receptors for EMF.
Since all food webs are uniquely tied together, there are negative cascading effects across all ecosystems.

Species sensitivity to EMFs.

Other species have vastly more complex electromagnetic sensing tools than humans, as well as unique physiologies that evolved to sense weak fields. Many species are highly sensitive to the Earth's natural electromagnetic fields, as well as geographic and seasonal variations. In fact, it appears that most living things — including many species of mammals, birds, fish, and bacteria — are tuned to the Earth's electromagnetic background in ways once considered as "superpowers" but are now known to be physiological, even as mechanisms are still imperfectly understood.

For example, many animals have been observed sensing earthquakes long before human instruments detect them, including snakes and scorpions that seek shelter; cattle that stampede; birds that sing at the wrong times of day; and female cats that frantically move kittens.

This ability is likely due, in part, to numerous species reacting to changes in the Earth's magnetic field and electrostatic charges in the air detected through a naturally occurring mineral called magnetite found in many species.

Cattle exposed to various magnetic field patterns directly beneath or near power lines exhibit distinct patterns of alignment showing evidence for magnetic sensation in large mammals, as well as overt behavioural reactions to weak ELF-MF in vertebrates. implying cellular and molecular effects. Roe deer also consistently align their body axis in a general north–south direction and orient their heads northward when grazing or resting.

Also, bodies that are predominately parallel to the ground, which includes most four-legged mammals, rather than a perpendicular upright gait, conduct EMF in different ways than vertical species like humans, apes, and other primates. Species that hug the ground, like snakes, salamanders, and frogs, have unique exposures to ground currents, especially on rainy nights when water, as a conductive medium, can increase exposures. This may make some species more sensitive to artificial ground current caused by electric utility companies using the Earth as their neutral return to the substation.

Conclusions.

Effects from both natural and man-made EMF over a wide range of frequencies, intensities, wave forms, and signalling characteristics have been observed in all species of animals and plants investigated. The database is now voluminous with in vitro, in vivo, and field studies from which to extrapolate.

The majority of studies have found biological effects at both high and low-intensity man-made exposures, many with implications for wildlife health and viability. Ambient environmental levels are biologically active in all non-human species which can have unique physiological mechanisms that require natural geomagnetic information for their life's most important activities.

The EMFs from power lines and electrical devices have a much lower frequency than other types of EMR, such as microwaves, radio waves or gamma rays. However, a low frequency wave does not necessarily mean that it is low energy; a charging cable for a phone produces a low frequency, low energy electromagnetic field, while a high-tension power line can create a much higher energy electromagnetic field that is still low in frequency.

EMR associated with power lines is a type of low frequency non-ionizing radiation. Electric fields are produced by electric charges, and magnetic fields are produced by the flow of electrical current through wires or electrical devices. Because of this, low frequency EMR is found in close proximity to electrical sources such as power lines. As current moves through a power line, it creates a magnetic field called an electromagnetic field. The strength of the EMF is proportional to the amount of electrical current passing through the power line and decreases as you move farther away.

For instance, many species can sense natural DC magnetic fields in diverse ways including migratory bird species (38, 39); numerous insect species including honeybees (40, 41); fish (42–47); mammals (48); bats (49); molluscs (50), and bacteria (51, 52). Some bird species may actually 'see' the Earth's magnetic fields via complex magnetoception capabilities (53) located in their eye and beak areas.

We have a long over-due obligation to consider potential consequences to other species – an obligation we have thus far not considered before species go extinct.

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