Learning from the Experts Webinar Series

Assessing Offshore Wind Electro-magnetic Fields in Our Communities

October 16, 2024

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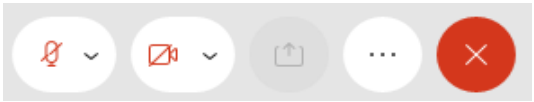

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Learning from the Experts

This webinar series is hosted by NYSERDA's offshore wind team and features experts in offshore wind technologies, development practices, and related research.

DISCLAIMER:
The views and opinions expressed in this presentation are those of the presenter and do not represent the views or opinions of NYSERDA or New York State.

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Speakers

With you today

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New York State Energy Research and Development Authority (NYSERDA) Invitation

Assessing Offshore Wind Electromagnetic Fields in Our Communities

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Objective & Experience

- The New York State Energy Research and Development Authority (NYSERDA) is working to advance development of offshore wind energy as a key part of the State's ambitious clean energy transition.
- NYSERDA invited Exponent to discuss electromagnetic fields from offshore wind energy generation and how questions about potential health effects of **onshore** installations are assessed.
- Exponent 's experience includes the preparation or review of environmental assessments for onshore and offshore generation and transmission projects in the U.S., Canada, and Europe. We have assisted the federal government, utilities, infrastructure developers, municipalities, and state regulatory agencies.
- The content of this presentation is general in scope and based on scientific and technical references cited, not any specific project.

Who We Are

Exponent is a multi-disciplinary engineering and scientific firm dedicated to solving important science, engineering, and regulatory issues for clients

Presentation Outline

Introduction

1. **Offshore/Onshore Transmission**
   - **Types of magnetic fields – AC vs. DC**
   - **Sources and characteristics of AC and DC magnetic fields**
   - **Project sources of magnetic fields**
2. Onshore Cable Technologies
   - AC and DC transmission
   - Cable Configurations
     - Duct banks
     - Designs minimize magnetic fields
3. Health Research and Standards
   - Scientific Review Process
   - National and International Reviews of Research
   - Exposure Guidelines

Section 1:
Offshore/Onshore Transmission

Does electricity generated by offshore wind farms affect magnetic field exposure onshore?

What you need to know.

Onshore Magnetic Fields Can Differ
Depending on how electricity is transmitted

To date, all offshore wind projects transmit electricity onshore as either:

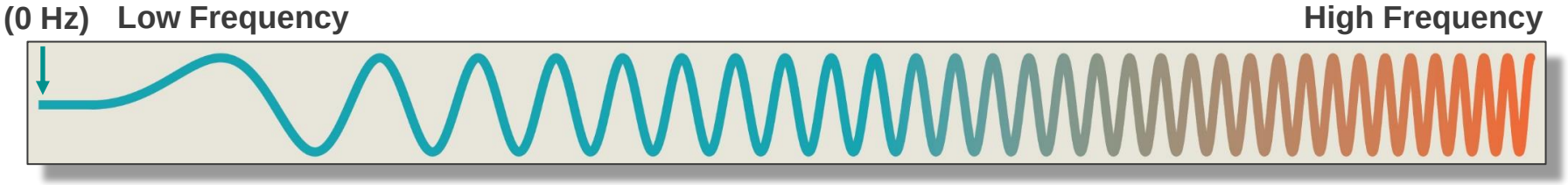
- Alternating Current (AC) at frequency of 60 Hertz (Hz)

  or

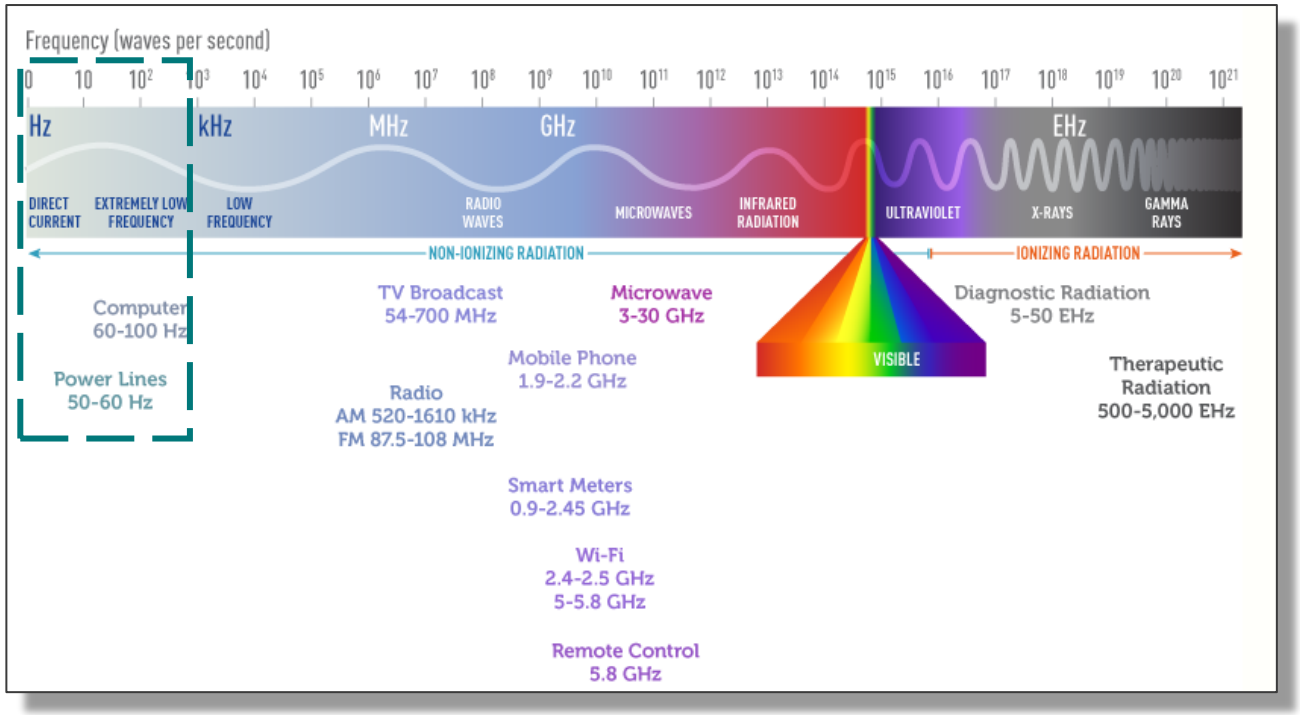
- Direct Current (DC) at a frequency of 0 Hz, then converted to AC current

Differences between Magnetic Fields are Determined by Frequency

- Key Characteristic is FREQUENCY.
- Frequency refers to the number of times per second that the field changes direction
- Measured in units of Hertz (Hz)

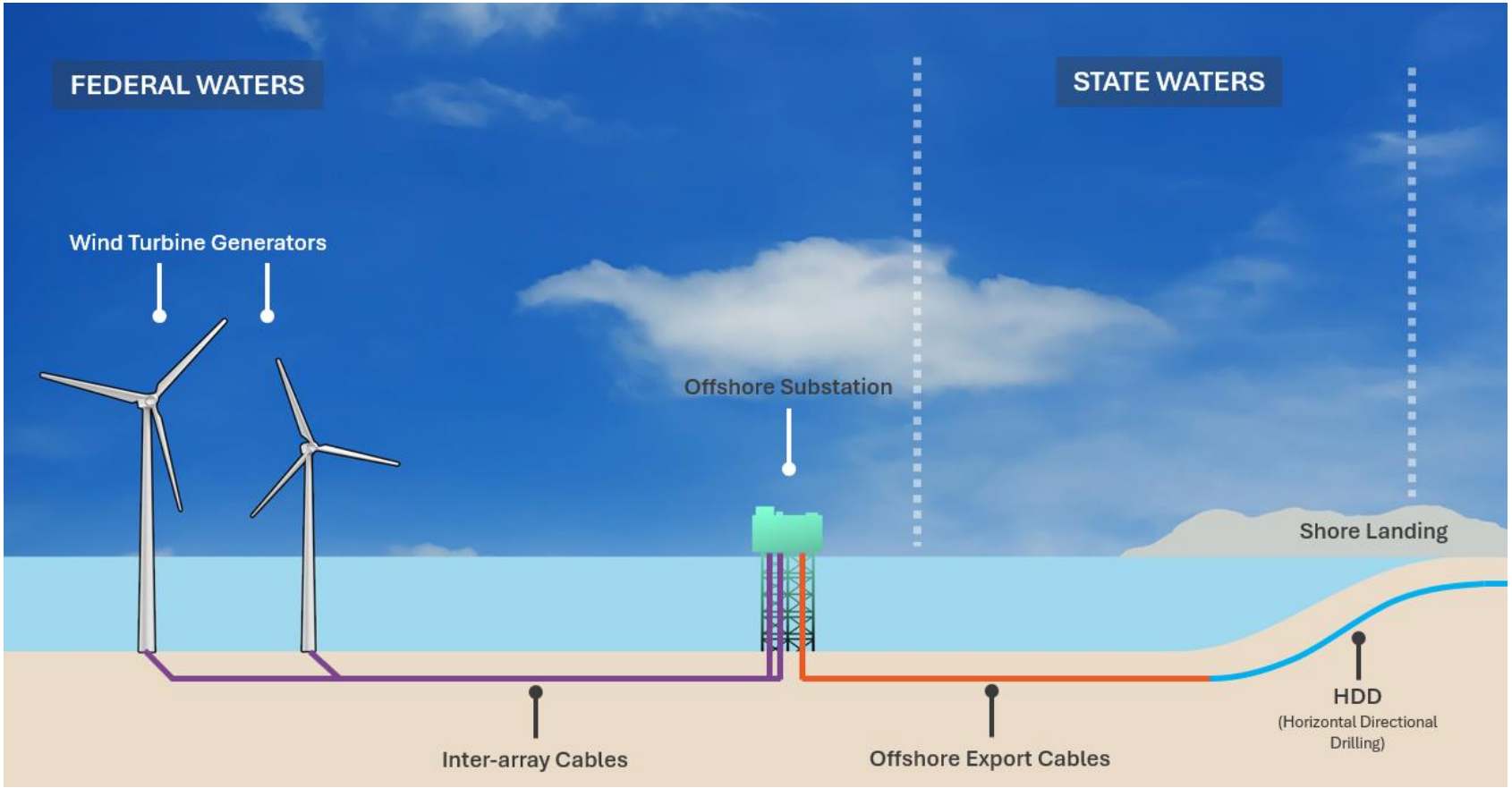


Significant Magnetic Fields Only at DC (0 Hz) and AC Frequencies (60 Hz) Above Buried Cables

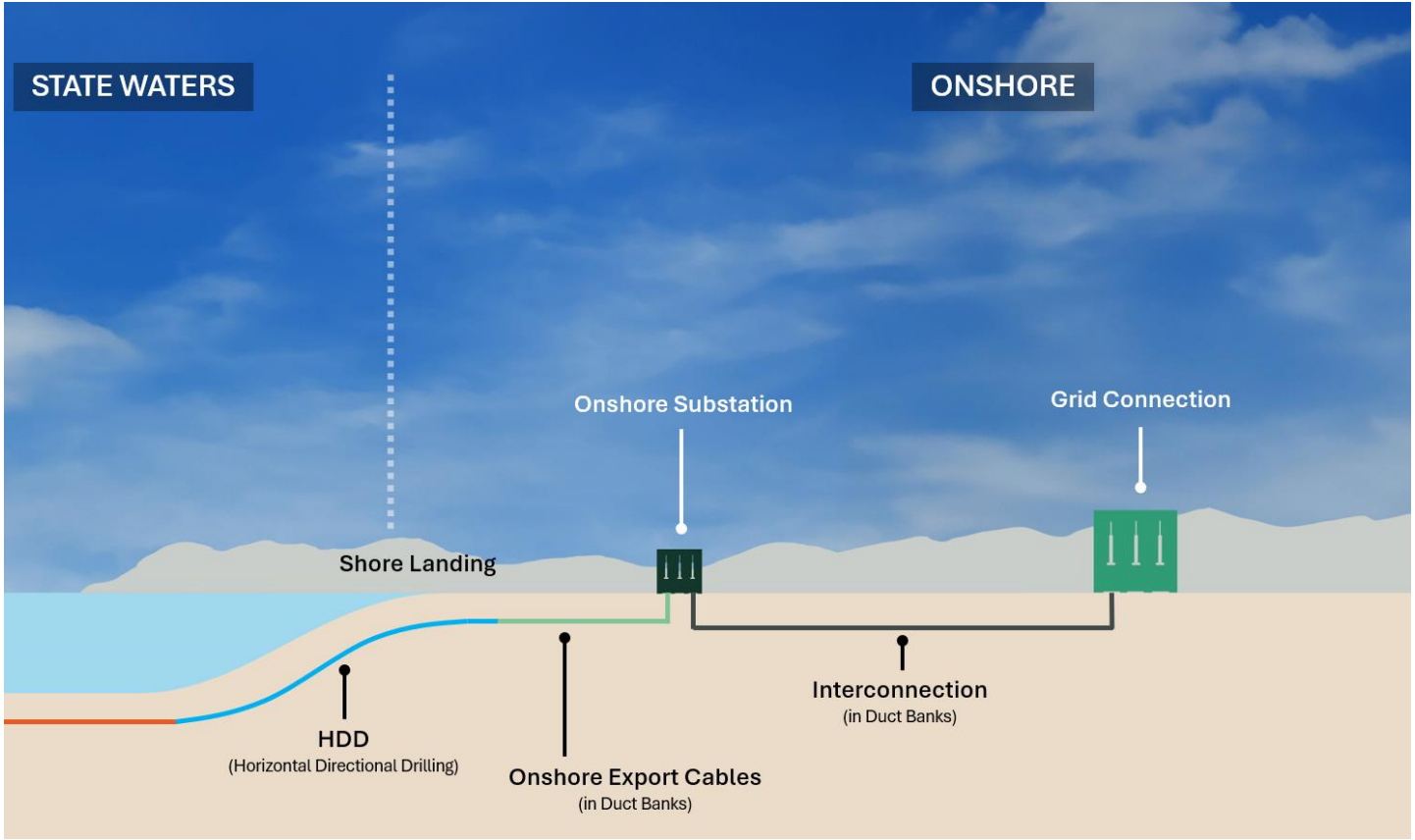


National Cancer Institute (https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/electromagnetic-fields-fact-sheet)

Generation / Transmission of Electricity Offshore



Transmission of Electricity Onshore



Note: The electric field created by the voltage on underground cables is effectively blocked by cable construction and the surrounding earth.

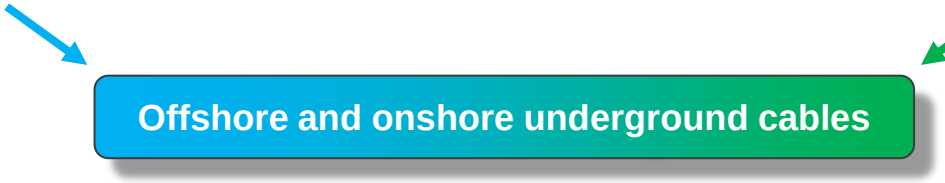
Common Sources of Magnetic Fields

Static or Direct Current (DC) Magnetic Fields (0 Hz)

- Earth (static magnetic field from the earth)
- Magnets, headphones
- Electric trains
- MRI
- **DC power lines**

Alternating Current (AC) EMF 60 (Hz)

- Commonly referred to as EMF
- Home appliances
- Building wiring
- Grounding systems (e.g., water pipes)
- **AC power lines**



Challenges to Understanding Magnetic Fields

- Vast and complex body of scientific research
- Magnetic fields are difficult to conceptualize
- Inappropriate comparisons to magnetic fields of other frequences

  AC, DC, RF fields are not the same! Nor are they 'ionizing radiation'
- Un-vetted sources, e.g., new media, Internet searches
- Inaccurate or out-of-date sources
- Misunderstanding of technical studies
- ‘Cherry picking’ – selective referencing of evidence

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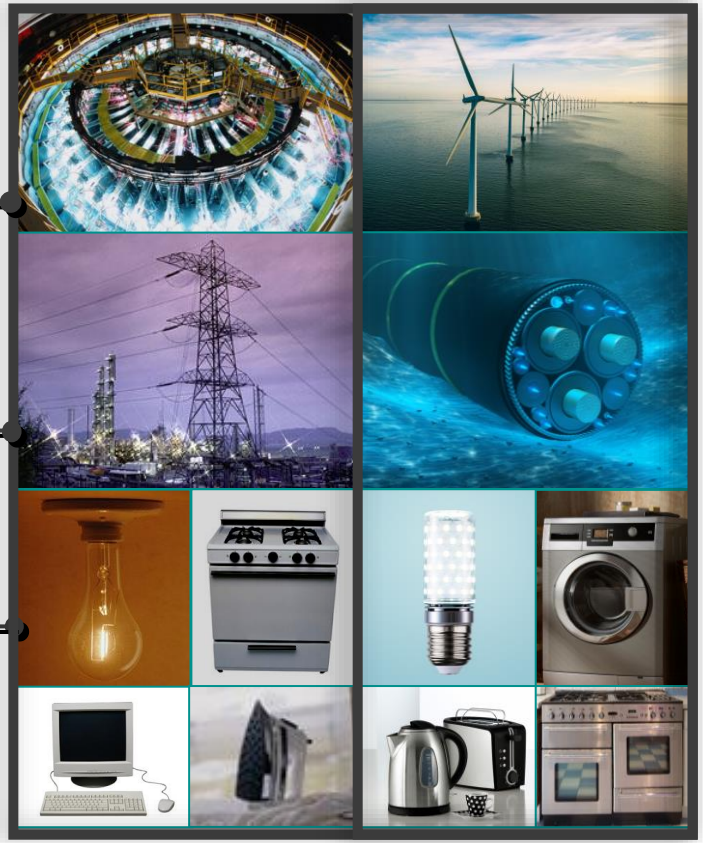
Section 2:
Onshore Cable Technologies

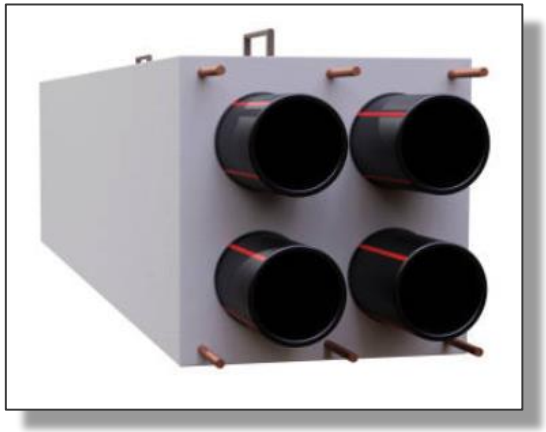
What are Electric and Magnetic Fields

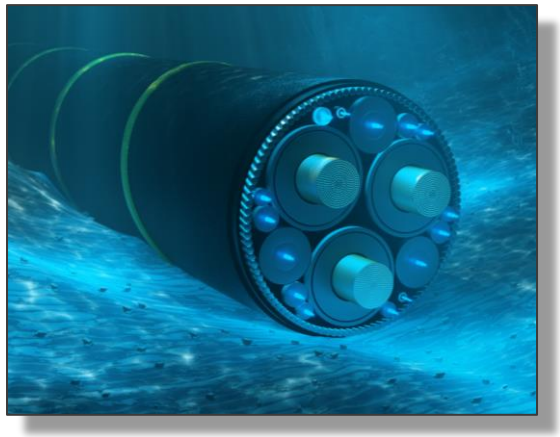
- Electric and magnetic fields are properties of space surrounding anything that:
  - **Generates**
  - **Transmits, or**
  - **Uses electricity**



Underground vs Overhead Power Lines

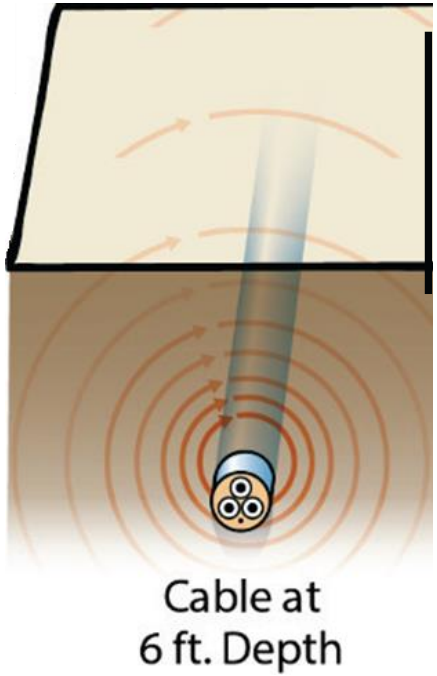
- Overhead power lines are sources of both electric and magnetic fields
- Underground and submarine cables shield the electric field





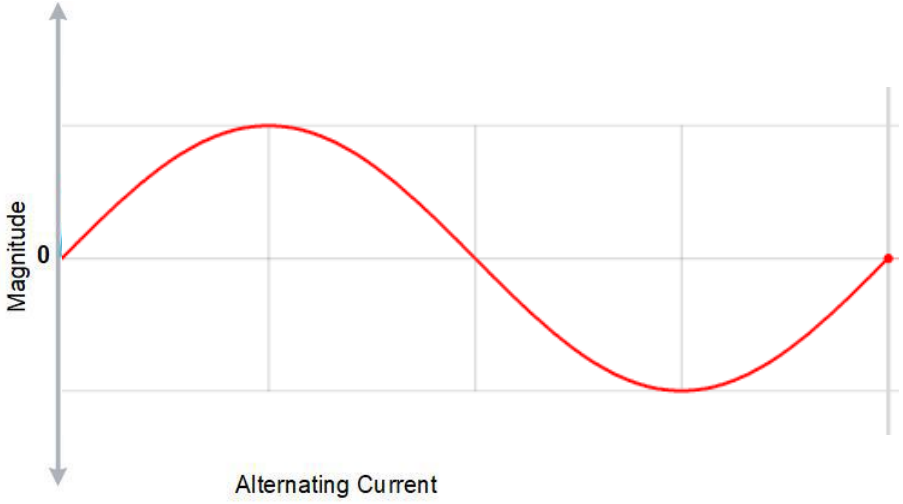
Properties of Magnetic Fields (AC and DC)

- Produced by the flow of electric current
- Measured in units of milligauss (mG), gauss (G), or microtesla (μT)
- Strength decreases quickly with distance from the source
- Not blocked by common objects



Modified from: CSA Ocean Sciences Inc. and Exponent. 2019. Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2019-049. 59 pp.

AC vs DC Electricity & Magnetic Fields



* Source: https://commons.wikimedia.org/wiki/File:Circle_cos_sin.gif

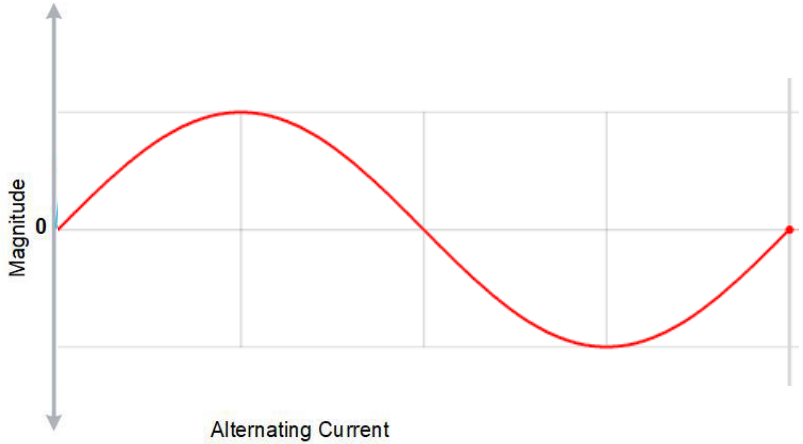
AC Magnetic Fields

Common Sources of AC Magnetic Fields

Alternating Current (AC)
EMF 60 (Hz)

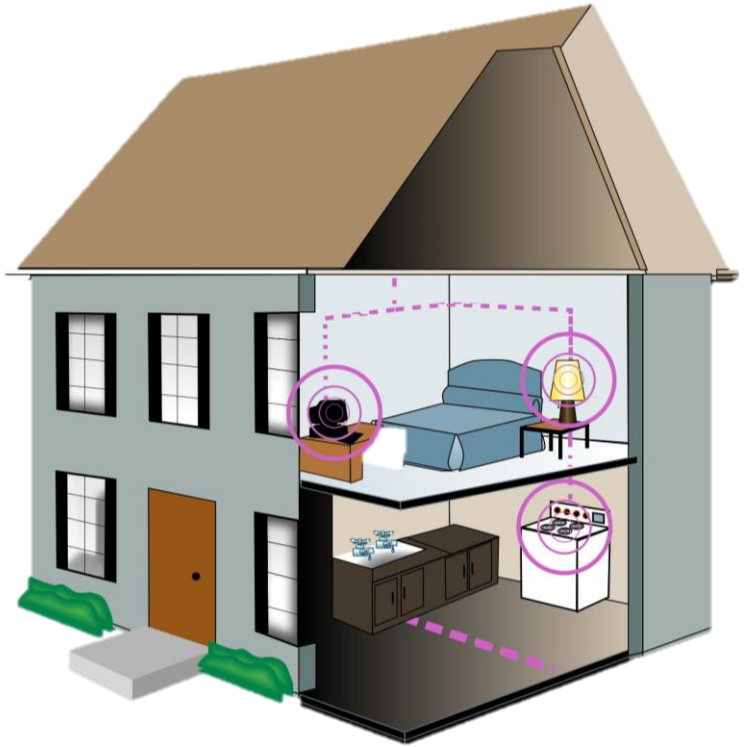
- AC power lines
- Home appliances
- Building wiring
- Grounding systems (e.g., water pipes)

Commonly referred to as EMF



Household Sources of AC Magnetic Fields

- Indoors, the primary sources of magnetic fields in most homes and buildings are the electrical wiring and appliances



AC Magnetic-field levels (mG) in the Home*

	Distance from Source		
Source	**6 inches**	**1 foot**	**2 feet**
Hair dryer	300	1	--
Electric shaver	100	20	--
Blender	70	10	2
Can Opener	600	150	20
Toaster	10	3	--
Vacuum cleaner	300	60	10
Power saw	200	40	5

*Values represent median magnetic field levels, measured in units of milligauss (mG)

Source: Electric and Magnetic Fields Associated with the Use of Electric Power, National Institute of Environmental Health Sciences (NIEHS) and National Institutes of Health, June 2002

AC Magnetic Fields Also Decrease Rapidly from Power Lines

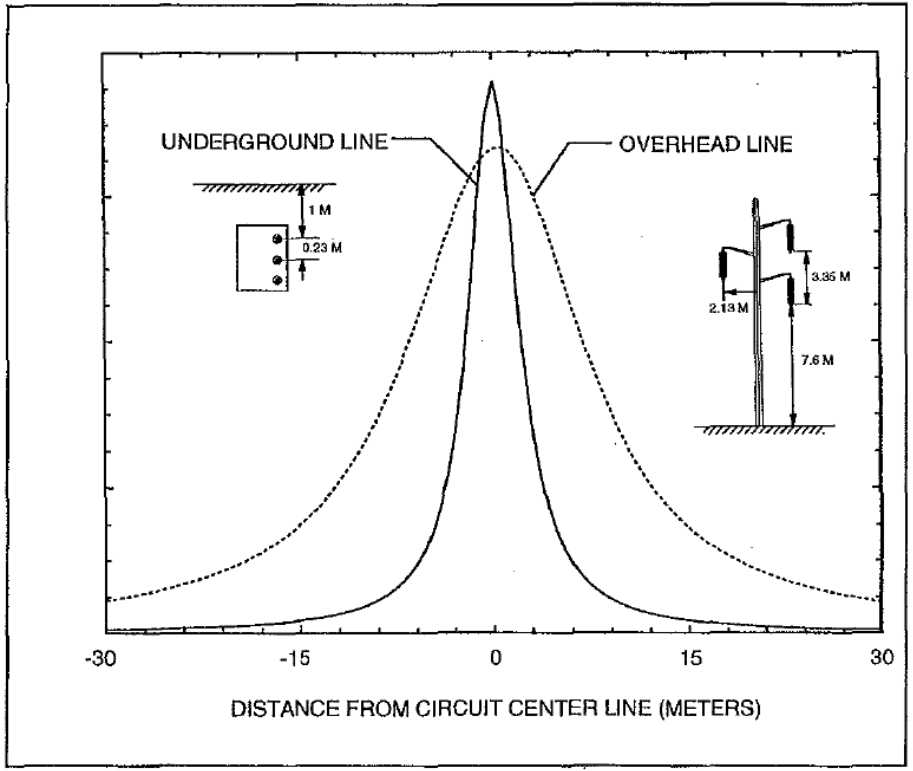


Figure 2-1. Comparison of the magnetic field from typical overhead and underground transmission lines.

Electric Power Research Institute Technical Report 102003 Transmission Cable Magnetic Field Management

AC Power Line Sources of Magnetic Fields

- Magnetic-field levels from power lines vary with voltage, design, and distance from the lines
- Distance of most power lines from residences reduces AC magnetic field levels at homes

Typical magnetic-field levels near AC power lines

Power Line Type (Example)	Magnetic Field (mG) Under/Over Line	Magnetic Field (mG) at ROW	"ROW" Width (ft)
Overhead Distribution†,‡	12	5.6	25
Underground Distribution†,‡	24	2.1	25
Overhead 115 kV‡	30	6.5	50
Overhead 230 kV‡	58	20	50
Overhead 500 kV‡	87	30	65
Underground Line from Offshore Wind§	57	3.7	25

Sources:

†: Electric Power Research Institute Technical Report 114200 Electric and Magnetic Field Management Handbook. (Assuming 150 A of electrical current)

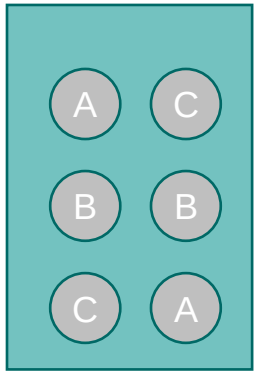
‡: Electric and Magnetic Fields Associated with the Use of Electric Power, National Institute of Environmental Health Sciences (NIEHS) and National Institutes of Health, June 2002

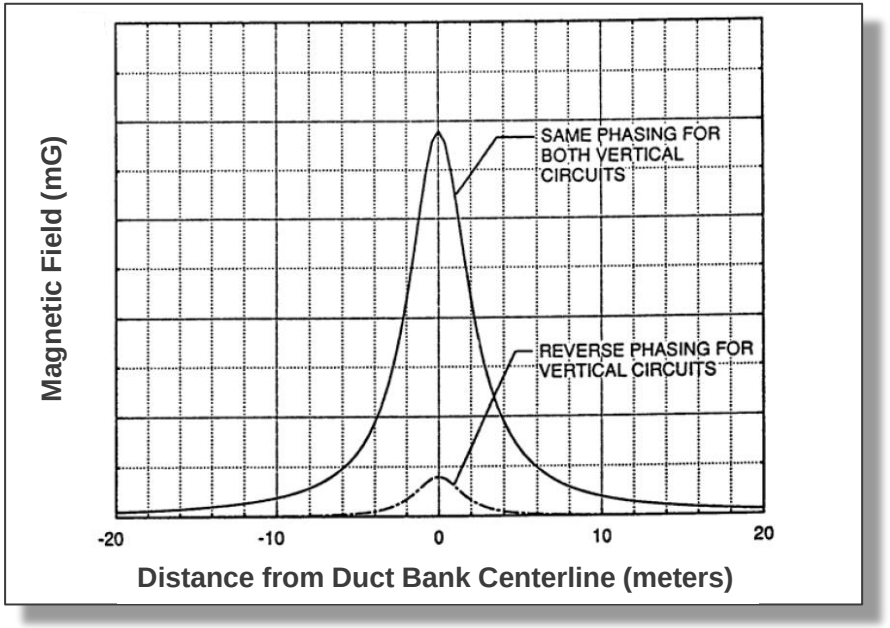
§: Median value at average loading from Construction and Operations Plan for: CVOW, Revolution Wind, Empire Wind 1 and 2, Mayflower Wind, South Fork Wind Farm, EFSB filing for Vineyard Wind

Methods of Reducing AC Magnetic Field Levels

AC Duct Banks

- Underground installation
- Minimize conductor-conductor spacing
- Increase voltage
- Burial depth
- **Phase optimization**





Modified from: EPRI Technical Update 1013906. EMF Field Management and Impact on Underground Transmission Cable Ratings. December 2007, Figure 4.4

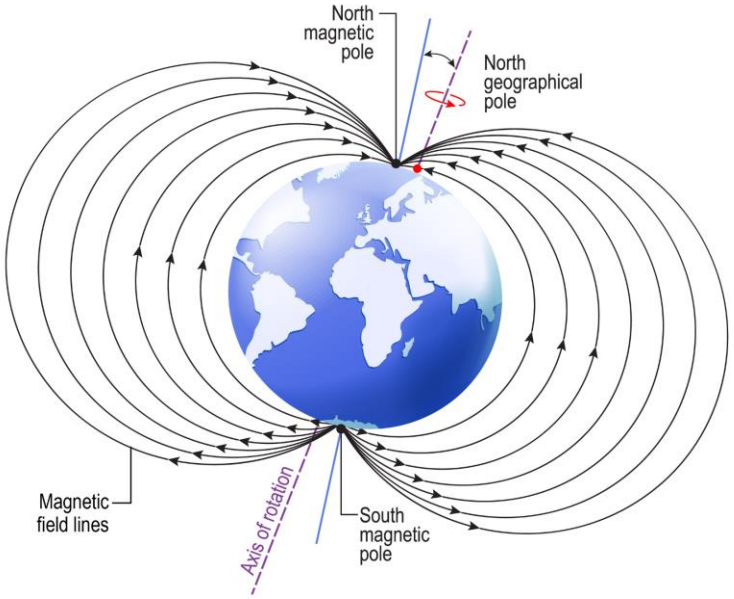
DC Magnetic Fields

Common Sources of DC Magnetic Fields

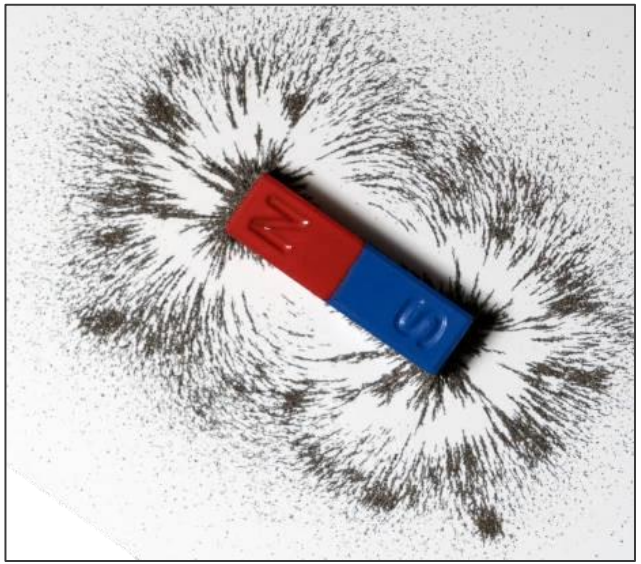
Static or Direct Current (DC) Magnetic Fields (0 Hz)

- Earth (static magnetic field from the earth)
- Magnets, headphones
- Electric trains
- MRI
- DC power lines

Static (DC) Magnetic Fields



Earth's Static Geomagnetic Field
~ 300–700 milligauss (mG)



* International Geomagnetic Reference Field (IGRF-13) Model
https://ccmc.gsfc.nasa.gov/modelweb/models/igrf_vitmo.php Accessed 10/10/2024

Typical Static Magnetic-Field Levels from Common Natural and Man-made Sources

Source	Magnetic Field Level (mG)
Natural Sources	
Earth's geomagnetic field in NYC*	510 mG
Man-made Sources (WHO, 2006)	
Refrigerator magnets	~100,000†
Battery operated appliances	3,000 – 10,000
Electrified railways	< 10,000
MRI machines	15 million – 40 million

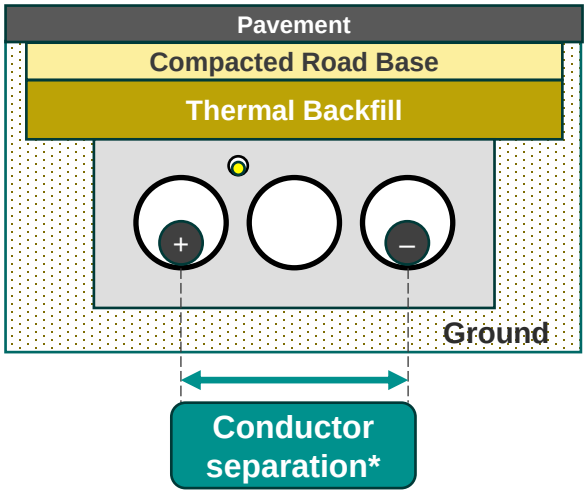
* IGRF-13 Model for 2024 https://ccmc.gsfc.nasa.gov/modelweb/models/igrf_vitmo.php Accessed 10/10/2024

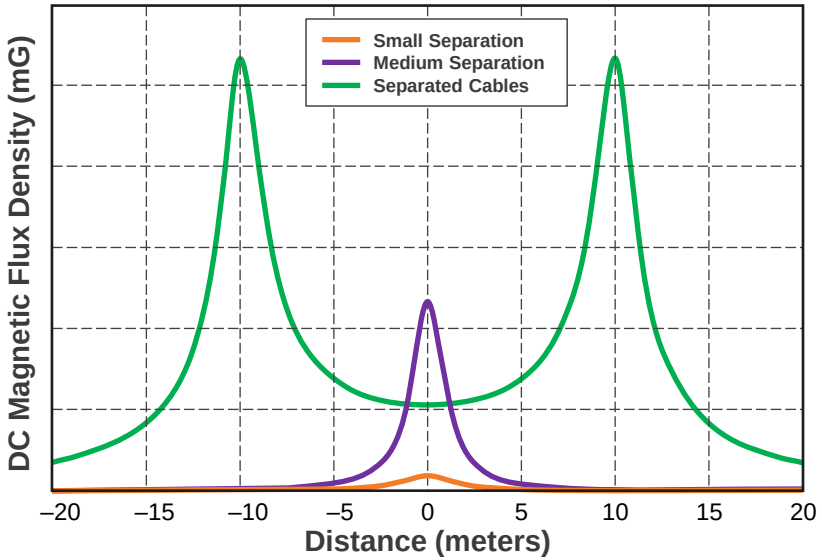
† US National High Magnetic Laboratory, https://nationalmaglab.org/about-the-maglab/around-the-lab/maglab-dictionary/tesla Accessed 10/10/2024

Methods of Reducing DC Magnetic Field Levels

DC Duct Banks

- Underground installation
- Increase voltage
- Burial depth
- **Conductor separation***





Modified from: *Normandeau, Exponent, T. Tricas, and A. Gill. 2011. Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09, Figure 4.1-9*

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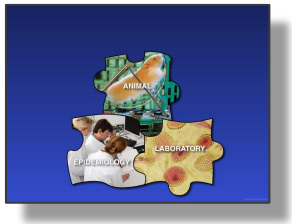
Section 3:
Health Research and Standards

How Health Agencies Review Scientific Studies

Step 1: Panels of experts are assembled

Step 2: Assessment focuses on review of **all** relevant scientific evidence



Step 3: Results of relevant studies are assessed **together** to form a conclusion

Process is designed to:

- ✔ Give more weight to studies of higher quality
- ✔ Prevent studies with a given result from being selectively chosen
- ✔ Create consistency and transparency
- ✔ Reduce the potential for bias

Overview of the Scientific Review Process

- All research studies have important strengths and limitations
- Scientific process involves consideration of *all* the evidence
  - Human studies (epidemiology studies)
  - Animal studies (*in vivo*)
  - Laboratory studies of cells and tissues (*in vitro*)
- Each study can be considered a piece of the puzzle!
  - When examined all together, provides a more complete picture of the exposure-disease relationship

Agency Reviews of AC or DC Fields

Scientific Organization	Country / Agency	Publication Dates
Federal-Provincial-Territorial Radiation Protection Committee (FPTRPC)	Canada	1998, 2005
International Commission on Non-Ionizing Radiation Protection (ICNIRP)	International	1998, 2003, 2009, 2010
National Institute for Environmental Health Sciences (NIEHS)	United States	1998,1999
International Agency for Research on Cancer (IARC)	United Nations	2002
National Radiological Protection Board (NRPB)	United Kingdom	2004
Swedish Radiation Protection Authority (SSI)	Sweden	2007, 2008
World Health Organization (WHO)	United Nations	2006, 2007
Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)	European Commission	2007, 2009, 2015, 2023
Health Council of the Netherlands (HCN)	Netherlands	2009
Swedish Radiation Safety Authority (SSM)	Sweden	2009, 2010, 2013, 2014, 2015, 2016, 2018, 2019, 2020, 2021, 2022, 2024
The European Health Risk Assessment Network on Electromagnetic Fields (EFHRAN)	European Commission	2010, 2012

Summary of Scientific Consensus on AC Magnetic Fields

- The large body of scientific research on 60-Hz EMF has been reviewed by many national and international public health and scientific agencies

- None of the reviewing agencies have concluded that AC magnetic fields, at the levels we are routinely exposed to in our everyday lives, cause or contribute to cancer or any other adverse health effects

Research on AC Magnetic Fields

- Some epidemiologic studies have reported an association between estimated long-term exposure to 60-Hz AC magnetic fields at high <u>average levels</u> and childhood leukemia

Epidemiologic Evidence

- Other explanations for association could not be excluded
- Larger, more recent studies have reported weaker or no associations

Experimental Evidence

- Animal studies as a whole do not show adverse effects
- No causative biological mechanism identified

Conclusions of Scientific Agencies

- **<u>None</u>** have concluded that AC magnetic fields cause childhood leukemia
- SCHEER (2023) concluded that “overall, there is weak evidence concerning the association of ELF-MF [magnetic field] exposure with childhood leukemia”

Summary of 0-Hz DC EMF Health Research

- Similar to that of AC fields, research on DC fields has been extensively published and reviewed by health and scientific agencies (e.g., WHO, SCENIHR)
- Research on DC magnetic fields, including that related to DC power lines, has not confirmed that exposure to these fields, even at high levels, poses any long-term health effects

Limits on Exposure to 60-Hz AC Fields

- There are no federal standards or guidelines for limiting exposure to 60-Hz AC electric and magnetic fields
- Some states have developed limits for 60-Hz electric fields and/or magnetic fields
  - Not based upon health-based risk assessments
- In **New York**, new transmission lines must comply with the standards established by the New York State Public Service Commission (NYSPSC) in 1990
  - Set to maintain AC 60-Hz EMF levels from new transmission lines to the levels produced by existing lines.
  - Cannot exceed at the edge of ROW:
    - Magnetic fields: 200 mG
    - Electric fields: 1.6 kV/m

Limits on Exposure to DC Magnetic fields

- The U.S. Food and Drug Administration specifies that MRI devices pose no "significant risk" for static magnetic field exposures up to **40,000,000 mG** for newborns and **80,000,000 mG** for all older persons (FDA, 2014).
- Some implanted medical devices may be affected by DC magnetic fields.
  - Standards specify that implanted medical device “shall not be affected by static magnetic fields of flux density of up to [**10,000 mG**]” (ANSI/AAMI/ISO Standard 14117:2019)
- There are no health effects of exposure to DC magnetic field of the earth (**≤ 700 mG**).

Health-Based Limits

- Guidelines for public exposure to AC and DC magnetic fields have been set by two international scientific organizations
  - Based on their review of the health research and reviews by other health and scientific agencies

Fields	International Committee on Electromagnetic Safety (ICES, 2020)	International Commission on Non-Ionizing Radiation Protection (ICNIRP, 2009; ICNIRP, 2010)
AC Magnetic Fields	9,040 mG	2,000 mG
DC Magnetic Fields	--	4,000,000 mG

AC and DC Fields: State of Science

"Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals."

"Despite extensive research, to date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health."

– World Health Organization (2024)

https://www.who.int/news-room/q-a-detail/radiation-electromagnetic-fields

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Thank You!

Notice

The findings presented herein are made to a reasonable degree of scientific certainty. Not all aspects of electromagnetic fields could be addressed in this overview presentation. The opinions and comments formulated during this assessment are based on observations and information available at the time of the investigation. No guarantee or warranty as to any reviewed condition is expressed or implied.

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- Article VII Permitting Process for Offshore Wind

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