

EMF, RF and the Smart Grid

Purpose: This document provides a basic description of the concepts of electromagnetic frequency (EMF) and radio frequency (RF) including an explanation of their applicability to the electric utility industry.

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1. Key Background Terminology

Radiation – The process in which energetic particles or energy travel through a medium. Note: Radioactive elements are found naturally in the air, water, and soil. We are actually exposed to radiation every day (i.e. the sun, consuming fruits such as bananas, smoke detectors, naturally occurring radioactive elements like potassium and carbon, which make up 0.2% and 18% of the human body respectively, etc.).

Electromagnetic radiation (EMR)- A form of radiation that exhibits wave-like behavior. Examples of EMR in the home are emissions from your cell phone, wireless router, cordless phone, baby monitor, microwave, and numerous other devices.

Ionizing Radiation – This type of radiation **can** remove electrons from atoms or cells (creating charged particles or ions) and therefore can cause significant damage or physically alter the atoms or cells (think X-rays or gamma-rays). This **is NOT** the type of radiation associate with Smart Meters or the Smart Grid.

Non-Ionizing Radiation – This type of radiation **can't** remove electrons from atoms or cells and instead causes them to move around or vibrate. Examples of this type of radiation are sound waves (vibrations processed by our ears), visible light, and microwaves (those your cell phone, Smart Meters, and wireless routers use to communicate). This **is** the type of radiation we are most intrigued with understanding in relation to the Smart Grid.

2. Common Terms Associated with the Smart Grid

EMF – Electromagnetic Field

Definition:

An electromagnetic field (EMF or EM Field) is the field produced by charged particles. The electric field component is created by the presence of stationary charged particles while the magnetic field component is created by charged particles in motion (e.g. the current that powers devices in your home).

Electromagnetic radiation (EMR) is generated by anything that uses electricity and the electromagnetic spectrum is the range of all possible frequencies of EMR. Examples of EMR are radio waves (radio frequency is simply a type of EMF), microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. A table of the electromagnetic spectrum is shown in Figure 1.

Smart Grid Association:

It is common to hear the term EMF in reference to the radio waves or microwaves that Smart Meters use to communicate. It is also common to hear the term being used to describe low frequency waves generated by the current in high voltage power lines. Using EMF to describe these waves is a way to generalize the entire spectrum of electromagnetic frequencies, and while it is technically correct, it should be noted that using the appropriate

term such as radio frequency, visible light frequency, extra low frequency (ELF), etc. provides additional detail as to which frequency is being referred to. It is also common to hear EMF used when referencing Electric and Magnetic fields as one. Again, proper terminology is needed to more accurately describe the type of radiation being discussed. Please see Figure 1 for the full range of EMFs.

Extremely Low Frequency (ELF) Waves

Definition:

Extremely Low Frequency waves are defined as the frequencies between 3 to 300Hz (ANL, 2011). Even though this is a non-ionizing type of radiation, there has been a significant number of studies looking at the impacts of long term exposure of low level ELF waves on people's health. Much of this is looking at the impacts of the ELF emissions from high power transmission lines. Many of these studies have been referenced as rational as to why low-level wireless smart grid EMF interference may not be healthy for humans. Wireless Smart grid communication solutions **do not** emit ELF emissions similar to those generated by high power transmission lines and therefore the studies on ELF emissions do not provide any insights as to the potential impacts of low level EMF from wireless smart grid solutions.

Radio Frequency and Microwaves

Definition:

As mentioned above, radio frequency (RF) is simply a type of electromagnetic radiation. Radio-frequency is defined arbitrarily as electromagnetic radiation in the range of 3 kHz to 300 MHz. Microwaves include radiation whose frequencies range from 300 MHz to 3,000 GHz.

Smart Grid Association:

Smart Meters can use radio waves or microwaves to communicate with other meters or devices in the Smart Grid. The specific residential Smart Meter to be used in Naperville, the Elster Rex2 series, operates in an unlicensed 902 – 928 MHz band to avoid interference with other wireless devices. These frequencies are very similar in nature to those waves used by cell phones, baby monitors, wireless routers and many other commonly used household devices. The key factor to remember is that while a cell phone, wireless router, etc. is constantly emitting a high frequency signal, the residential Smart Meter in Naperville will be programmed to transmit a maximum of 76 seconds per day. It should be noted that all Smart Meters and associated equipment that will be deployed within Naperville fall within the FCC's regulated maximum permissible exposure levels.

3. Other Terms to Understand

Dirty Power

Definition

Electrical pollution is the generation of electromagnetic frequencies in various ranges generated by stray voltage in electrical lines. The generation of these “dirty” frequencies can be caused by a poorly grounded or ill-maintained utility infrastructure. (Quain, 1997)

Smart Grid Association

This term is sometimes utilized in an attempt to imply that smart meters will create dirty power in the power grid as their increased demand for electricity will create more noise within the distribution system. It is important to remember that surges in electrical demand are caused by the sudden starting of large devices that draw large amounts of power, such as your home air conditioning unit or industrial electric motors. *Smart meters require only a small amount of power to operate and will not create dirty power within the grid.*

Radiation Associated with Nuclear Power

The radiation associated with nuclear power plants is of the ionizing type (it can remove electrons from atoms) and should not be confused with any of the frequencies associated with the smart meter. Please see Figure 1 for a full list of the frequency spectrum and associated common devices that operate or emit at those respective levels.

(Cember, 1996)

4. Additional Resources

Smart Meters and Radio Frequency:

http://www.ci.naperville.il.us/emplibrary/Smart_Grid/NSGI-RF-FAQ.pdf

Electric Power Institute Study on RF Fields Associated with Smart Meters:

http://www.naperville.il.us/emplibrary/Smart_Grid/NSGI-EPRI-RFEMFstudy.pdf

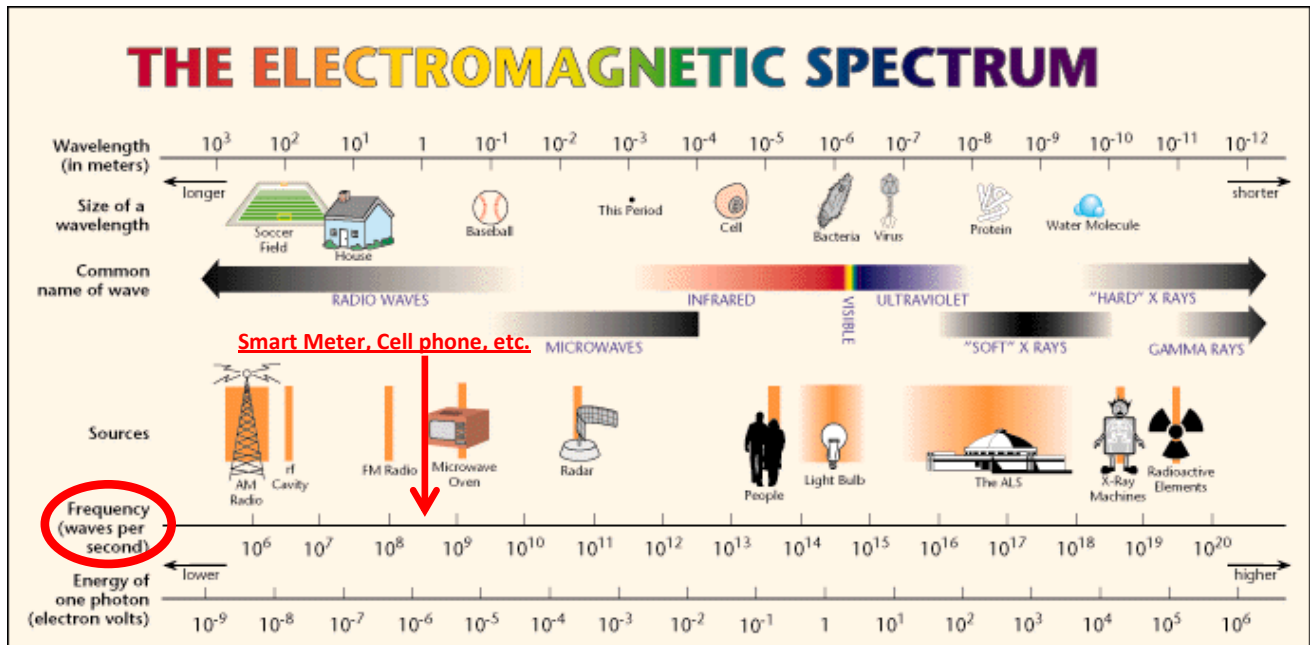
California Council on Science and Technology – RF Health Impact Study

http://www.naperville.il.us/emplibrary/Smart_Grid/RFHealthImpacts-CCST.pdf

FDA Radiation Resources:

<http://www.fda.gov/Radiation-EmittingProducts/ResourcesforYouRadiationEmittingProducts/default.htm>

Figure 1: The Electro Magnetic Spectrum



http://www.fms-corp.com/emfemibasics_emfspectrum.php4

Works Cited

Radiation Protection. (2011). Retrieved June 15, 2011, from EPA:

<http://www.epa.gov/radiation/understand/>

Cember, H. (1996). Radio Frequency Radiation and Microwaves. In H. Cember, *Introduction to Health Physics* (pp. 618-643). New York: McGraw-Hill.

Quain, J. R. (1997). *Protect Your PC From Dirty Power*. Retrieved June 15, 2011, from Fast Company:

<http://www.fastcompany.com/magazine/09/dirty.html>