

# Electromagnetic Radiation & Health **Factsheets**



**Building Biology Institute**  
The science of healthy buildings

*Electromagnetic fields are an emerging public health crisis  
that will go down in history as one of the most important  
mistakes made in the name of progress.*

—Camilla Rees, MBA

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## 5G Technology & Protection Strategies

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### **Associated Online Course**

[IBE 221.4](#)





**5G describes 5th generation cellular technology being introduced in the coming decade of the 2020's.** It is not 5.8 GHz, a Wi-Fi and cordless telephone frequency used for years. 5G primarily involves data connections, not voice calls or texts. Voice and texts use 2G (which will be phased out) and 3G, but voice and text will be managed by the data network.

5G will continue to include 3G and 4G LTE technology transmitting in the sub-6 GHz (600 MHz to 6 GHz) range for decades to come. Over time, new 5G antennas broadcasting in the super-20 GHz millimeter wave, or mmw, band (20 to 100 GHz) would be deployed. These super-20 GHz 5G antennas are proposed to be mounted at existing 4G macro cell tower sites as well as in many small cell antenna arrays closer to homes and in public places.

3G and 4G LTE antennas transmitting in the sub-6 GHz band would gradually be replaced by new antennas containing updated 5G technology. That new technology would include many elements under development for decades: Massive MIMO to increase the number of cellphone users in a given bandwidth and geographic area; on-demand beamforming, at least down to 2 GHz, to reduce interference between an increased number of cell signals in the same airspace and to allow 5G signals to penetrate buildings; full duplex to save bandwidth; dual capable 4G/5G cell phones; increased automation of the network; and placing both 4G LTE and 5G antennas on small cell antennas closer to user's handsets, i.e. nearer homes, businesses and public places.

Specifically, 5G proposes to bring 3G, 4G LTE, Wi-Fi and new 5G antennas closer to people through millions of small cell antenna arrays. 5G would first be deployed in pockets of dense population in urban centers located in public places, on and within buildings, and at existing 4G cell sites. Public Wi-Fi antennas would also be mounted on overhead utility poles on cable company lines.

The health effects of chronic exposure to cellular voice and data transmissions at any frequency and any generation are known to be harmful to all life, cumulatively over time and at close range. That includes the cell phone in your pocket. Exposure to 5G signals at sub-6 GHz and super-20 GHz bands are expected to accelerate the onset of ill health in people, pets, native animals, insects and plants in the biosphere, which are already under assault by RF transmitted by 3G and 4G LTE technology.

3G and 4G LTE antennas and technology would remain in place and continue to expand during the decade of 5G. Those who have developed microwave sickness, also known as electromagnetic sensitivity, are particularly vulnerable. Urban environments will be quite unhealthy for them, and for the rest of us, particularly when we are outside buildings. The needs of these individuals must be taken into consideration by public policy makers, as they are harbingers for the rest of us.

Signals from 5G antennas transmitting above 20 GHz can only penetrate into homes if beamforming technology is used. Otherwise, the millimeter wave signal does not pass through standard building materials nor glass. Beamformed 5G signals at any frequency can be effectively stopped with RF-shielding paint and building-grade metal foil. Unfortunately, most fabrics as well as copper and aluminum mesh that effectively block RF signals below 6 GHz are not expected to effectively block 5G beamformed signals above 20 GHz. Special silver fabric, however, may be designed that will be effective at blocking super-20 GHz signals.

New 5G antennas will only transmit a beamformed signal when a user's handset initiates a connection, on-demand. Beamformed signals would not scan the neighborhood and constantly transmit like existing 3G and 4G LTE non-beamforming antennas do now. However, always-on 4G LTE antennas would be installed along with 5G antennas at Wireless Telecommunications Facilities (WTFs) or base stations, which are additional names for small cell antennas, right in front of people's homes. Activists believe the vast expansion of always-on 4G LTE and Wi-Fi antennas close to homes in residential neighborhoods will be as much of a health risk as on-demand 5G beamformed signals.

RF meters in use today can only measure 4G LTE, Wi-Fi and 5G radio frequencies up to 2.7, 8, and 12 GHz, depending upon the model of your meter. RF meters in use today cannot measure 5G signals in the super-20 GHz range. Spectrum analyzers and RF meters do exist that measure super-20 GHz signals, but they are expensive. Also, since they measure in average mode and only use diodes for signal detection, they are not sensitive or effective enough, according to some RF experts, to measure the type of signals proposed for use in 5G above 20 GHz. Fortunately, new affordable RF meters are under development that will be designed to measure specific 5G frequencies planned for use by the cell industry in the super-20 GHz mmw band.

5G is not a done deal. Deployment would take longer and be more involved than most people, including industry, believe. Deployment is being challenged world-wide by an ever-increasing number of activists and advocates who are making progress at getting municipalities to delay or block implementation. The health effects of 5G technology need to be fully and impartially studied before deployment of more 4G LTE antennas or any new 5G technology occurs, especially close to where people live and in public places.

Field testing by the cellular industry shows that beamformed signals can reach up to at least one-half mile with download speeds of 1 Gbps. Municipalities should therefore mandate that new cell antennas of any generation, whether 3G, 4G LTE or 5G, as well as public Wi-Fi, be placed only in commercial and industrial areas and not in residential neighborhoods. There should be a 2,500-foot setback between wireless transmission facilities (small cell antenna arrays) and residences. 5G transmitters, if they are deployed at all, should only be co-located with existing 4G transmission facilities and mounted at least 150 feet up, always above the highest roof line of neighboring houses and not at ground level.

It should be remembered that 5G signals need a clear, unobstructed straight path to reach their destination, which is the handset of subscribers. Hills, trees, and buildings all block RF signals to varying degrees, particularly in the mmw band above 20 GHz. Also, super-20 GHz 5G signals will not broadcast out in all directions continuously, like 3G and 4G LTE signals do now.

Remember, beamformed 5G signals project in a rather narrow beam targeted at the user's handset on-demand. The signal is powerful and very brief, emitting a burst of energy as it flashes past.

Beamformed 5G signals are designed to follow you as you move around with a cellphone or tablet in your hand. However, testing shows a 5G signal is often lost when you move the handset. When that happens, you are handed off to a 4G LTE antenna. The 5G connection is stronger when the handset is stationary.

You want to maximize the distance between you and the cell antenna by keeping new 5G antennas on existing 4G towers. That dilutes the signal strength near people's homes. We also want 5G antennas up high to avoid beamformed signals from penetrating into upstairs bedrooms or to pass through one home to get to another one behind it.

Effective hardwired alternatives to wireless connections do exist. These include Fiber to the Premises (FTTP) as well as hardwired Ethernet cables within homes and businesses to allow occupants to cut back on the use of wireless devices. Hardwired data cables provide fast, stable, reliable, secure and safe data and voice connections. Once hardwired Ethernet connections are set up, then place your computer in Airplane mode and make sure Wi-Fi and Bluetooth are not still enabled

In essence, avoid 5G devices and beware of 4G. Oppose siting of 4G LTE and 5G antennas in residential neighborhoods close to homes. Support efforts to utilize hardwired fiberoptic infrastructure that is already in place to provide high-speed data transmission to our homes in a safer, wired way at a fraction of the cost of using wireless for the "last mile".

Join the efforts of 5G and wireless activists, in alerting the public and elected officials to the dangers of long-term exposure to wireless devices and all EMFs. Consider having your home evaluated by an EMF expert certified by the Building Biology Institute

[buildingbiologyinstitute.org](http://buildingbiologyinstitute.org)

Follow the advice to reduce use, increase distance and favor hardwired alternatives to wireless connections and devices whenever and wherever possible.



## Baby Monitors

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### **Associated Online Course**

[IBE 221.1](#)

The joy of becoming a parent can rarely be compared to any other but often comes with the worry of wellbeing of the baby, especially during the moments when a parent is not able to directly supervise the newborn. This very fear inspired the creation of baby monitors.

Today's market is saturated with varieties of systems that offer baby monitoring not just audible and visual, but tracking of baby's temperature, movement, breathing and more. However, the majority of these tools comes at a high price of exposing babies to electromagnetic radiation. Unfortunately, the subject of EMF exposure safety is conveniently not even mentioned by the manufacturers in the manuals or on their websites. Consumers are not informed of the kinds of electromagnetic fields that the infant is exposed to while the monitor is on.

When discussing Electromagnetic radiation from baby monitors, we are looking at three types of fields: electric, magnetic and radio frequency. With wireless baby monitors, the most concerning exposure comes from radio frequency, however the other fields should be considered by the parents, as well.

All wireless baby monitors sold in the US emit high frequency radiation and they do it continuously when the monitors are on, and often, when they are on standby. The exposure levels depend on the strength of the signal and proximity to the source. Some monitors just a meter away from the crib show the readings equal to the microwave radiation exposure from a cell phone tower 50-100m away. Producers of the wearable monitors state that the Wi-Fi signal equals in strength to the one of the Wi-Fi routers, which is similar to operating a microwave oven next to the infant.

The majority of EMR safety studies involving humans is based on adults, not babies, whose bodies are just a fraction of the mass of a grown person. Frames of small children, especially their skulls, are still being formed, making their brains more susceptible to radiation, being more fluid with higher electrical permittivity and conductivity, able to absorb 50–100% more RF energy than the adult head.

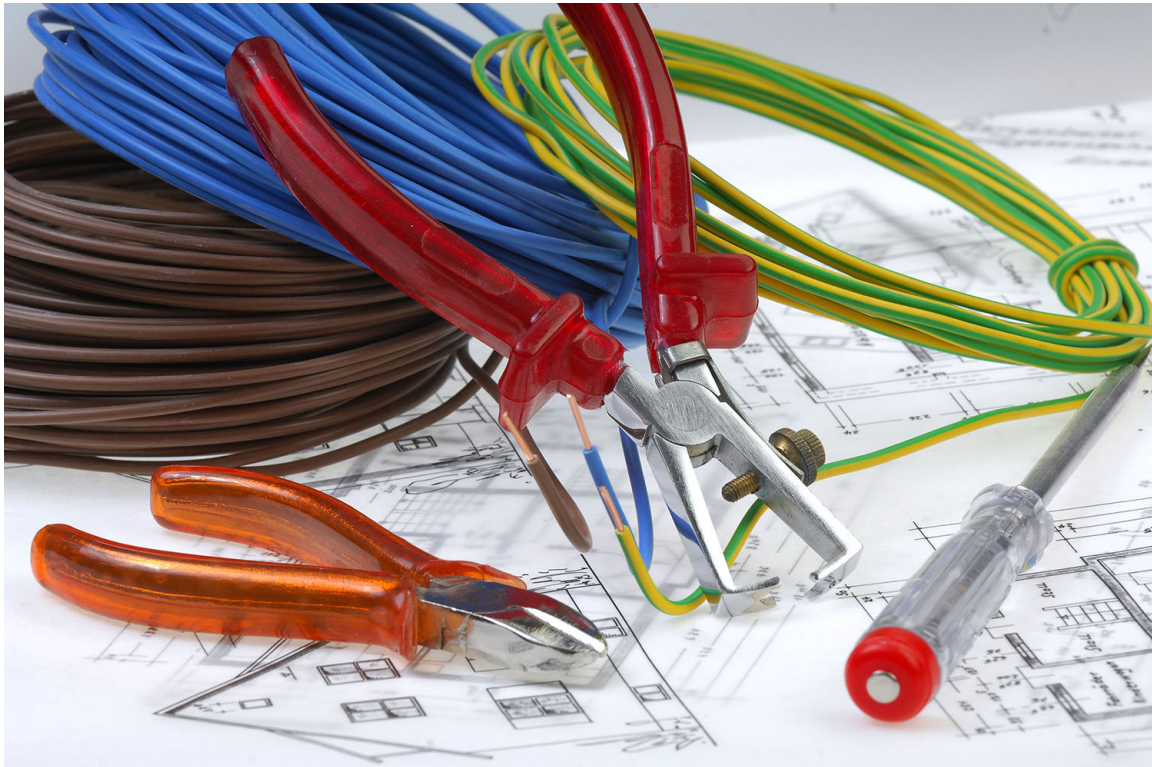
The most commonly used technology in operation of baby monitors has been DECT standard, which runs at 1.89 GHz or 2.4 GHz. From the health safety point, DECT system has raised a lot of concern in the last decades, the UK Health Protection Agency (HPA) claims that a DECT cordless phone's radiation could actually exceed the radiation of a mobile phone.

Wi-Fi connection bringing video monitoring convenience to the parents comes at the price of continuous emission of pulsing radiation coming both ways, even when not much communication is happening.

As more research comes out showing biological effect of Wi-Fi on human health, organizations around the globe start taking firm stands on limiting or banning the exposure of children to high-frequency radiation.

The first step in minimizing the EMF exposure is to realize that subjecting a baby to even the smallest amounts of electromagnetic radiation comes with a risk of it being unsafe. Taking a precautionary measure in the selection of a baby monitor is the safest choice a parent can make. Getting a wired monitor is the best and the only sound solution, even if comes with a small inconvenience of the parent's limited ability to move around. One option is to get a wired intercom. Another option is to purchase a monitor that comes with a capability of being used wired over a wired Ethernet system with wireless options completely off.





## Electrical Home Wiring

Building Biology Archive

**Associated Online Course**

[IBE 223.9](#)

Electricity is a hallmark of industrialized societies. In most of the Western world, homes not only offer the convenience of running water, but also the luxury of electricity. Electric kitchen appliances help us prepare daily meals, electronic office tools assist in managing an ever expanding load of information, and electronic communication devices keep us connected with the world. It is almost impossible to imagine life today without electricity.

On average, a modern home wiring system consists of about 20 electric circuits and 80 outlets (without electric heating) plus the myriad of electric appliances and electronic devices used on a daily basis. It is scientific fact that low-level electric, magnetic and other electromagnetic fields (such as those emanating from electric home wiring systems and common appliances) have biological effects. The “only” question remaining is the significance of those health effects, and their level of harm, particularly over long periods of time.

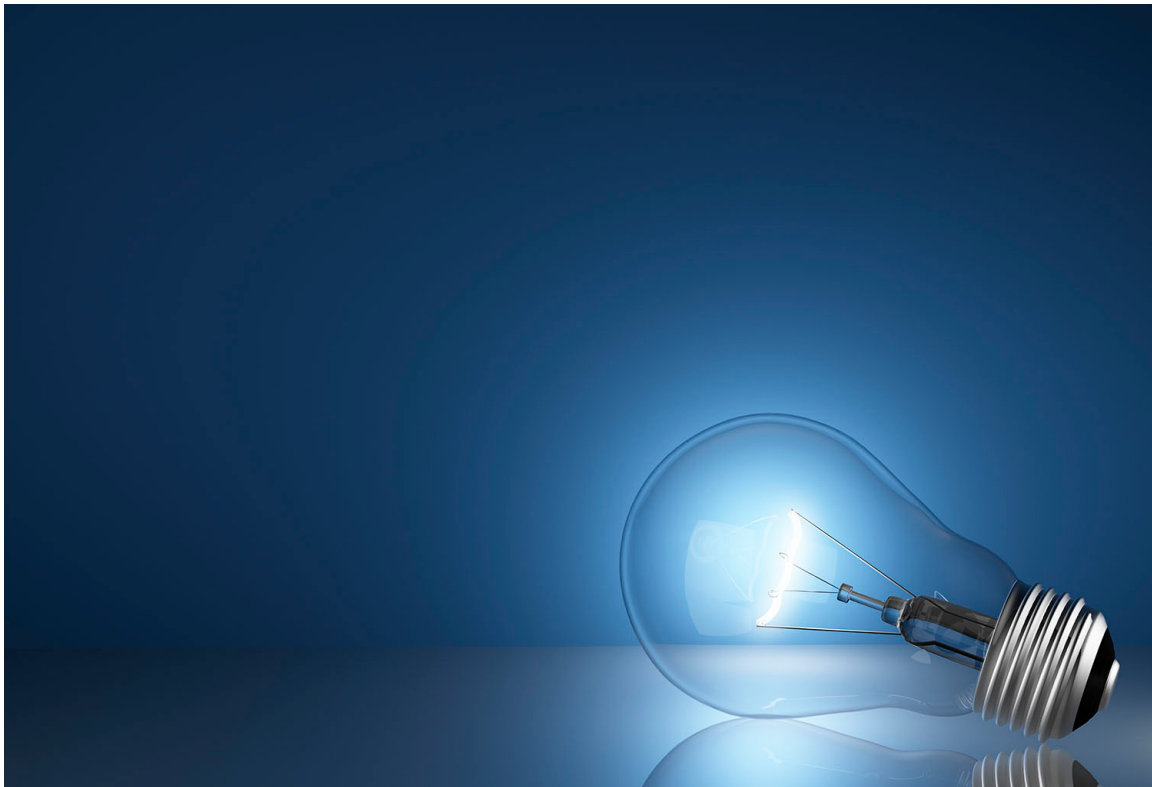
In this course, we will discuss the essential components of a low-EMR electric home wiring system, including:

- proper earthing system
- low-EMR wiring layout design
- shielded and twisted cables
- wiring-free walls
- demand or cut-off switches
- low-emission electric appliances and electronic devices

Home wiring systems are designed to protect users from electric shock and fire hazards. The National Electrical Code and local code requirements are written to achieve this end. Since those rules are not concerned with the biological effects of exposure to electric, magnetic and radio frequency fields, it is worthwhile to delve further. With rather little effort, simple precautionary steps (for example, cutting off power, shielding wires and paying attention to detail during installation) can be implemented to protect a home’s occupants from permanent exposure to low-level electromagnetic radiation.

The combined experience of a qualified electrician and a Building Biology Environmental Consultant provides the necessary knowledge for a low-EMR home wiring system. When all concerned parties work together as a team, it is possible to create a wiring system that not only meets all electrical code requirements, but even exceeds them to offer a healthy indoor environment with low-level electromagnetic radiation.

The goal of a low-EMR wiring system is to keep the exposure to undesirable human-made electromagnetic radiation as low as possible. In Building Biology, the smart use of power is not limited to making energy-efficient choices; rather, it extends to eliminating or reducing unnecessary electromagnetic stress by following smart wiring practices. The construction of a new home offers the unique opportunity to incorporate Building Biology principles for a low-EMR design right from the start. Any renovation or alteration always has the potential for major improvements.



## Electric Lighting

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### Associated Online Course

[IBE 221.13](#)

Electric lighting became available less than 150 years ago but it provides a convenience most people would find difficult to live without today. The use of artificial light has undoubtedly increased our productivity by effectively extending the working day and improved our safety. However, many of our modern lighting sources also come with an electromagnetic radiation and hazardous material burden. In addition, artificial lighting is one of the major consumers of electricity. The health and environmental impacts of modern electric lighting will be covered in this course. For information on how light, natural and artificial, impacts the health of our visual, circadian, and skin systems see *The Human Response to Light* course. As Building Biologists, we have the opportunity to design and/or modify the lighting in spaces in a way that optimizes human health while minimizing the environmental footprint.

Today, most modern cultures rely on artificial light in the form of electrically powered light bulbs, also known as lamps. Lamps can be divided into three main categories:

- incandescent
- discharge, which includes linear and compact fluorescent
- solid-state, (LED)

Each lamp technology has different characteristics that are important to consider for making healthy choices for humans and the environment. In addition, the associated components of lighting, such as dimmers and electrical wiring should also be evaluated from a Building Biology perspective.

In Building Biology, we use nature as the gold standard. Thus, we look to the properties of natural light to guide us when choosing lamps. The emission spectrum of light refers to the distribution of the different wavelengths and thus colors. Sunlight follows a smooth and continuous emission spectrum with no wavelengths missing. The distribution of colors in sunlight changes throughout the day. Dawn and dusk have high levels of red and yellow and are low in blue, while midday is very blue-rich. Thus, we look for lighting with similar spectral emissions knowing that our needs change throughout the day. Caution should be used when choosing lamps labeled as full-spectrum as this term is not regulated and often does not represent the qualities of sunlight. In addition to mimicking natural light we want electrical lighting with low levels of electromagnetic radiation and hazardous chemicals, while ideally low in energy use, and flicker free.

Incandescent bulbs work by conducting a current through a thin tungsten filament, resistively heating it to the point of incandescence. They are considered energy inefficient as most of the energy they consume (~90%) is released as heat rather than light. However, they are also free of flicker, low in all electromagnetic radiation, and low in hazardous materials. A regular incandescent bulb has a smooth spectral distribution close to that of sunlight during dawn or dusk.

Discharge lamps use electric current to excite a gas to illumination. These can be pressurized to achieve different spectral qualities. There are many types of discharge lamps. The most commonly used for general illumination in buildings are fluorescent lamps. Fluorescent bulbs are low-pressure discharge lamps where the gas is mercury. When mercury gas is excited by an electric current it emits mostly UV rays. The inner surface of the bulb thus must be coated with phosphors to convert the UV into visible light. There are two types of fluorescent lamps: linear, long tubular bulbs with a separate ballast, and compact, small lamps with the ballast built in. Fluorescent bulbs are 4 to 6 times more energy efficient than incandescent bulbs but can have issues with flicker and dirty electricity. Magnetic fields are also high for the magnetic-ballasted linear lamps. Of great concern is their mercury content, which poses a human and environmental health hazard at all life-cycle stages, production, use, and disposal. In addition, their spectral distribution is uneven with discrete narrow peaks at particular wavelengths and negligible emissions between peaks. Fluorescent lamps are, therefore, not recommended.

LEDs use solid-state, that is, semi-conductor technology. The technology of LEDs has advanced rapidly since they were first developed in the 1960s, and continues to do so. It is now possible to produce white LED lighting that comes close to emulating sunlight with a wide range of temperatures from 2700 K to 6500 K. LEDs are also very energy efficient. There is a large variation in the type and quality of components used in LED lamps today, resulting in end products that can differ tremendously in quality and thus, attributes related to health. Some LEDs generate high levels of dirty electricity and flicker. They also contain hazardous

levels of lead and copper. Most LEDs on the market have a spectral distribution with two main peaks, one in blue and other in the warm color range. However, advances have seen the development of candlelight style LEDs, which have a spectral distribution very similar to sunlight. High-quality LEDs can be a good choice as long as dirty electricity levels are tested before using.

Dimmers are another important aspect to consider when making healthy lighting choices. Dimmers generally generate high levels of dirty electricity and can even be a fire hazard when combined with non-dimmable lamps. The lowest dirty electricity option is not to use dimmers at all. Instead, use multiple light sources with different illumination levels. Some dimmers, called constant current reduction dimmers, that are designed to be used, and matched with, compatible LED light bulbs are low in dirty electricity.

Lamp technology has advanced rapidly in the last few decades, not only with solid-state technology but also with the development of smart lighting and visible light communication. Smart lighting refers to wirelessly controlled lighting. As with any wireless technology, smart lighting is not recommended in Building Biology. Visible light communication, also called light fidelity (LiFi), is the transmission of data on light waves. The light waves themselves may be safe, however, the data transmitted on the light waves have to be modulated onto a carrier signal. At this nascent stage, the health implications of LiFi are unknown.

Humans are not the only organisms affected by electric lighting. The presence of light at night is a major stressor on wildlife, especially nocturnal animals. Light at night is a form of pollution and is called ecological light pollution in reference to plants and animals. Ecological light pollution can attract or repel different organisms leading to potential changes in their foraging, reproduction, migration, and communication. A change in the behavior and health of one species ultimately affects others, leading to disturbances at the ecosystem level. Ecological light pollution, for example, can set migrating birds on the wrong path, discourage female turtles from nesting, and even cause algal blooms in lakes by discouraging zooplankton from migrating to the surface to eat algae at night. For the health of all organisms, it is important to minimize this type of pollution. Electric lighting is considered an integral part of life for most people today. Building Biology takes a holistic approach that looks at all aspects of lighting concerning the health of humans and the environment. This includes the type of lamps we choose as well as associated technology and reducing light at night pollution.





## Electromagnetic Radiation: Health

Sonia Hoglander, BSSE, MBA, BBEC, EMRS

### Associated Online Course

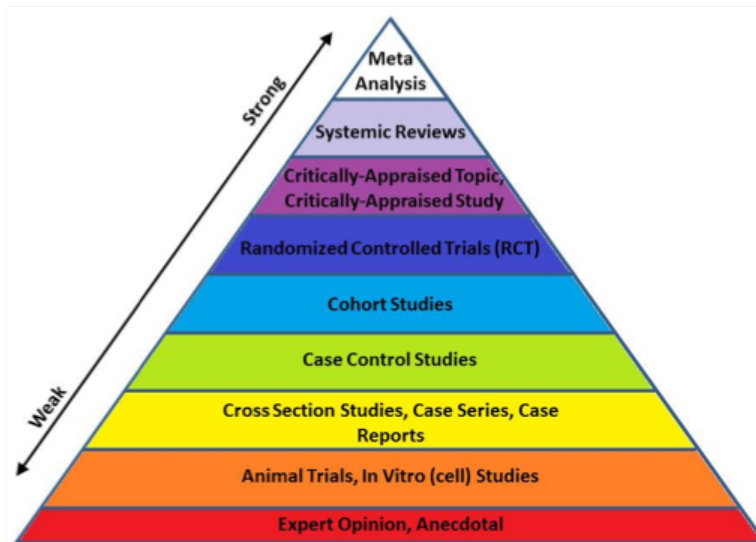
[IBE 221.9](#)

This is the second module of the prerequisite and fundamental course on electromagnetic radiation (EMR). This course discusses known biological effects caused by EMR as well as suspected ones. Additionally, official guidelines and exposure limits and how they compare with the ones established by Building Biology are discussed.

Various types of electromagnetic radiation sustain life on earth. In nature the quantity and quality of the many different electromagnetic energies surrounding us and flowing through us follow a very distinct pattern. It all starts with the sun. Though the sun gives off energy throughout the entire electromagnetic spectrum, only certain types penetrate the protective layers of the earth's atmosphere.

We can see with our eyes that visible light enters and we can feel on our skin that heat (infrared radiation) is also allowed in—both frequencies are essential to life. Most ionizing radiation, however, beginning at the upper end of the ultraviolet (UV) radiation, is fortunately absorbed through the ozone layer protecting life on earth from its damaging effects. There is another protective shield, the ionosphere, which absorbs most of the non-ionizing radiation at the lower end of the electromagnetic spectrum. This is a large radio window (wavelengths run from about one centimeter to about eleven-meter waves.), allowing whispers from the farthest corners of our galaxy (pulsars, quasars) to reach us.

Underneath these atmospheric covers, the earth itself also gives off various types of electromagnetic energies. Wrapped in the fold of its own magnetic field, the earth keeps a more or less steady rhythm so essential to the pulse of life.



**Hierarchy Of Evidence**

In the course of evolution, all living organisms have adapted themselves to this very unique radiation climate prevalent on planet Earth. This natural balance is being threatened now because over the last 100 years humans have been very busy adding their own versions of electromagnetic energies without giving due consideration to the biological implications.

"Our exposure to these fields is about 10 to the 10th times ( $10^{10}$ ) what we were exposed to in earlier human evolution. A huge increase in exposure—10,000 million times now—keeps going up as new devices get introduced. To do this without any sense of the dangers makes no sense to me." —Dr. Martin Pall

It is the mission of the Building Biology to educate, encourage and empower interested individuals and organizations in how to create and sustain healthy living and work spaces in harmony with nature. The detailed knowledge of our electromagnetic realities and the conscious awareness of the electromagnetic interactions between cosmos, earth and living organisms will encourage the student to make responsible use of the vast electromagnetic resource for the benefit of all.

This course provides a context for discussing health effects of EMR. It begins by explaining the various sciences involved in research and conclusions found to date. We include how research is rated according to the hierarchy of evidence. There is an overview of plausible mechanisms underlying the development of disease; induced current, voltage gated calcium channels (VGCC), melatonin, and DNA damage. Once the basic context is provided, each category of EMR (direct current and alternating current magnetic and electric fields, high-frequency radiation, radioactivity, and terrestrial radiation) has a section describing specific studies and observations regarding impacts on biology. The course is wrapped up with an overview of guidelines and exposure limits established by various global and national agencies and why they differ from Building Biology standards based on the precautionary principle.

# EMR Safety from Outside Sources

Building Biology Archive

## Associated Online Course

[IBE 221.4](#)

External sources of non-thermal electromagnetic radiation (EMR) are omnipresent in our modern world. Both urban and rural neighborhoods, landscapes, public spaces and byways are filled with cell towers, radio towers, high-voltage power lines, electrical transfer/relay stations, smart meters, cell phones, and artificial lighting. Smart phones are especially noxious because powered-on cell phones constantly transmit a radiofrequency signal to the relay tower, regardless of whether the phone is in-use or not.

The three forms of electromagnetic radiation that we will address in this course are:

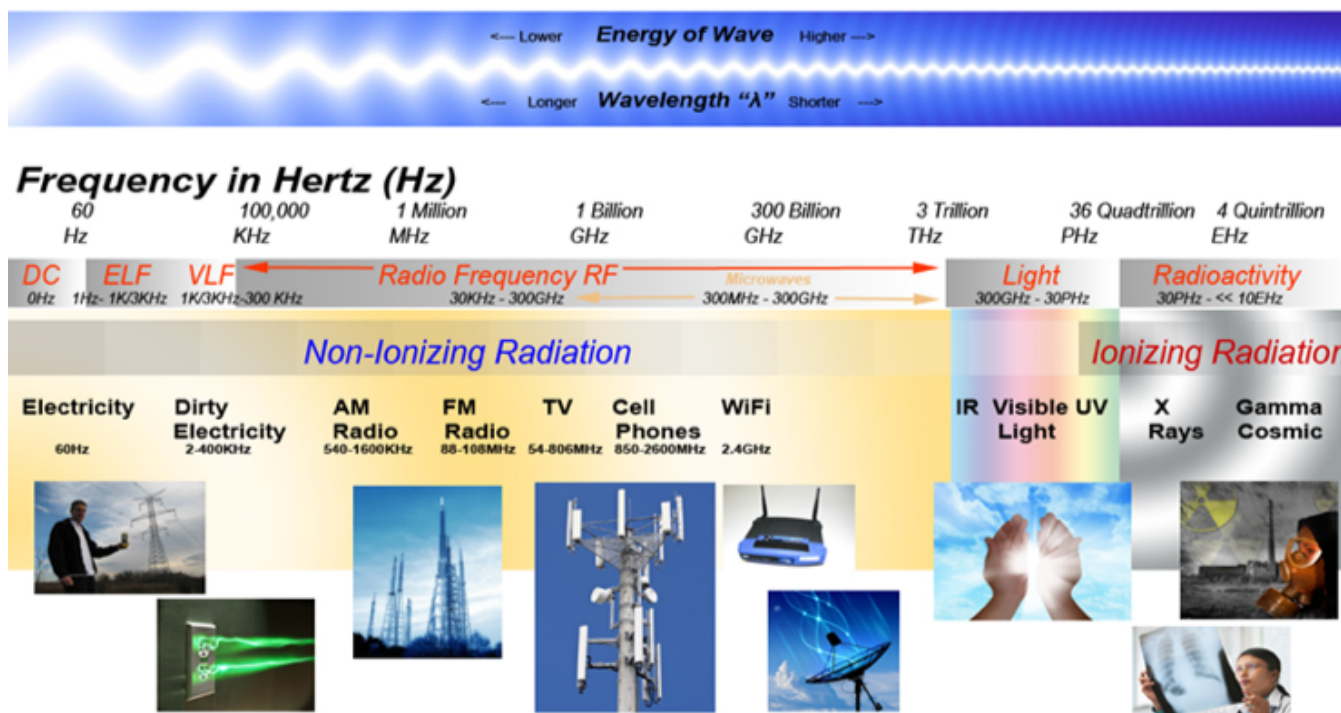
- static electric and magnetic fields
- AC electric and AC magnetic fields
- radiofrequency radiation

These EMR sources are considered non-thermal, non-ionizing radiation since they do not generate heat nor break molecular ions (unlike sources such as X-Rays and Gamma Rays, which are classified as both thermal and ionizing radiation). The lack of heating effects from “non-thermal” EMR provides no heat-based physiological warning nor recognition of the biological and metabolic harm that may be caused by such exposure.

In North America, there are no federal regulatory standards that establish safe human exposure limits for non-thermal radiation. Telecommunications companies insist that EMR levels emitted from their products and towers fall well within federal government limits established by the Federal Communications Commission (FCC) in 1996 (and not updated since). However, they are referring only to the limits set for thermal radiation, and not the other biological effects that can occur at non-thermal levels.

There are, in fact, thousands of peer-reviewed scientific studies that indicate adverse health effects from man-made, non-thermal EMR on humans, animals, and plant life. The potential human health risks vary according to such variables as: type of field, field strength, voltage, current, charge, grounding, frequency, wavelength, and power density. In humans, EMR impacts the body at the cellular level, diminishing the ability of cells to defend themselves, and disrupting the cells’ natural processes. For example, cell phones, when carried in immediate proximity to the body, have been shown to result in the production of ineffectual sperm cells and impenetrable ovum, to catalyze rogue cells in breast tissue, and to cross the blood-brain barrier.

The International Institute of Building Biology & Ecology has developed a series of standards that set limits for acceptable levels of human exposure to all sources of nonthermal radiation. There are defined methods and easy practices for mitigating EMR exposure, without forsaking modern communication and lifestyle conveniences.



## EMR Safety in the Built Environment

Building Biology Archive

### Associated Online Course

[IBE 221.3](#)

There are many simple, immediate, and cost-free steps that anyone can take to help reduce their exposure to electromagnetic toxins within the built environment, without forsaking the modern conveniences to which everyone has become accustomed.

The following steps can easily merge into your daily lifestyle without inconvenience:

1. When talking on the cell phone, use speakerphone or an AirTube headset to reduce exposure to your head.
2. Avoid carrying your cell phone against the body (like in a pocket, sock, bra or pants). Cell phone manufacturers cannot guarantee that the amount of radiation you're absorbing will be at a safe level.
3. Choose wired internet (i.e. ethernet cords and wired routers) at home instead of wireless systems. If you do use wireless systems, unplug them during sleeping hours or when you are not using them.
4. Choose wired (i.e. non-wireless) options for tech and accessories such as computers, laptops, printers, gaming consoles and handsets, mouse, keyboard, video cameras, security systems, HVAC, audio speakers, headphones, microphones and other accessories.
5. Use a corded home/office landline phone whenever possible to minimize the need for a cell phone. Remember that cordless home phones emit radiofrequency, and the cordless phone base station continually emits RF. As an initial step, unplug the cordless phones when not in use (and at night).

Despite taking these steps in the home environment, electromagnetic radiation can nonetheless pervade a home, school, or commercial building from within. The myriad sources of EMR include:

- **AC ELECTRIC FIELDS:** AC voltage in electrical installations, cables, appliances, outlets, walls, floors, beds, high-tension power lines and other power / electrical lines.
- **AC MAGNETIC FIELDS:** AC current in electrical installations, cables, appliances, transformers, motors, overhead and ground cables, power lines, and railways.
- **RADIOFREQUENCY RADIATION:** cell phones, mobile mast towers and antennas, wireless routers and devices, trunked radio systems, line-of-sight systems, commercial radar and military radar, cordless DECT phone bases and handsets, wireless gaming consoles, smart meters, and smart home systems.
- **DC ELECTRIC FIELDS:** synthetic carpeting, drapes and textiles, vinyl wallpaper, varnishes, laminates, stuffed toy animals, TV and computer screens.
- **DC MAGNETIC FIELDS:** steel components in beds, mattresses, furniture, appliances, building materials; DC current in street cars, photovoltaic systems.
- **RADIOACTIVITY:** building materials, stones, tiles, slags, waste products, devices, antiques, ventilation, terrestrial radiation, location, environment.
- **GEOLOGICAL DISTURBANCES:** currents and radioactivity in the earth; local disturbances caused by faults, fractures, and underground water courses.
- **SOUND & VIBRATION:** traffic noise, air traffic, train traffic, industry, buildings, devices, machines, motors, transformers, bridges.

On a global scale, afflictions related to electromagnetic sensitivity are on the rise. Associated conditions and symptoms include: allergies and sensitivities, Chronic Fatigue Syndrome (CFS), neurological and behavioral disorders (including autism), autoimmune diseases, cancers, and Alzheimer's Disease. Public concern and questions about EMF exposure have increased as a result of media coverage of the research, studies and litigation. Although several environmentally-sensitive individuals have recognized EMF health effects for quite some time, it is taking longer for this information to be adopted mainstream by officials, experts, and the general public.

The Precautionary Principle directs us to heed early warnings from researchers and scientists who have published on the biological health effects of EMR, as well as from the personal experiences of the environmentally sensitive populations. As we progress in our modern world, preventative actions and protective policies will need to be developed to ensure public health, while establishing long-term sustainable systems and technologies.



# Electromagnetic Radiation: Science

by Sonia Hoglander, BSSE, MBA, BBEC, EMRS

## Associated Online Course

[IBE 221.6](#)

Course IBE 221.5 is the foundational and prerequisite electromagnetic course for Building Biology. It was translated to English, from German, by Helmet Ziehe in the 1980's. The International Institute for Building Biology and Ecology (IBE) was launched in the United States in 1987. Much of the content is based on work done by Wolfgang Maes an expert in Bau-Biologie out of Germany.

The course was reformatted and edited in 2012. This is the first major update of the material which is taught in the 212 Seminar on electromagnetic radiation (EMR). The original course included everything on EMR; the history, the science, the examination of health mechanisms and effects, measurement protocol and mitigations. The online course was 90 pages long. All updates to the material occurred in the 212 seminar which was evolving as the science and tools evolved. This new updated 204.3 incorporates all the new information that is relevant to a prerequisite course. The 212 Seminar remains the hands-on introduction and training for how the science presents itself in the world, how to use the equipment, and how to investigate the problems. The advanced seminar (312) goes into deeper detail about wiring errors, additional equipment and measurements, and mitigation strategies.

This module covers the science of electromagnetism and provides a thorough description of the vocabulary and concepts of electricity. It begins with a discussion of atoms and electrons, or the chemistry of our world, and then explains the physics of electricity like Ohm's law and Kirchhoff's law. It includes definitions of the various units and categorizations of the electromagnetic spectrum. From there each electromagnetic concept is explained in detail; direct current electric and magnetic fields, alternating current electric and magnetic fields including microsurge electrical pollution (also known as dirty electricity), high-frequency electromagnetic radiation (also known as radio wave and microwave frequencies), radioactivity (radon, gamma, alpha, beta), and terrestrial radiation (earth grids and geopathology). It includes explanations of the triboelectric series of static electricity, positive and negative air ions, subtle energy, Ley lines, Hartmann lines, Curry lines, the difference between diamagnetic and paramagnetic, and the difference between analog and digital signals. We also briefly introduce various modern technologies; "smart" meters, Wi-Fi, cordless phones, 5G cellular, and fracking. All of this is just scratching the surface of the overall electromagnetic science, but it is a comprehensive view of key concepts for understanding the complexities of the electromagnetic world we live in. There is also an interesting section translated from the original text about the history of earth radiation.

The focus of this course is electromagnetic terminology and concepts.

# Electromagnetic Radiation: Solutions

Sonia Hoglander, BSSE, MBA, BBEC, EMRS

## Associated Online Course

[IBE 221.8](#)

This is the third module of the prerequisite and fundamental course on electromagnetic radiation (EMR). This course discusses sources and causes, Building Biology testing methods, and mitigation—recommendations and remediation.

Common sources of electromagnetic radiation in our living environment are presented, specifying their general causes, distribution patterns and field characteristics. General principles and procedures specific to EMR testing methods in Building Biology are outlined. Overview of EMR surveys performed in sleeping areas, on properties, at workplaces and for building materials (this is the subject for the IBE 212 Seminar). Recommendations for how to reduce or eliminate one's exposure to harmful EMR in our living environment are introduced. The topic of mitigation is addressed in more detail in the IBE 312 seminar.



The Building Biology consulting approach is a simple formula; education (about sources and health effects), investigation (measuring and identifying) and mitigation. This course provides information on each category of EMR; direct current and alternating current electric and magnetic fields including microsurge electric pollution, high-frequency fields (both radio wave and microwave frequencies), radioactivity and terrestrial radiation.

Common sources are identified, the equipment used and how to use them is explained, how to approach each investigation, the Building Biology guidelines are noted for each measurement technique, and practical mitigations are discussed. This is a significant part of how Building Biology Principles (BBP) related to EMR are applied in the real world.

- **BBP-2:** Place dwellings so occupants are undisturbed by sources of man-made air, soil, water, noise and electro-pollution.
- **BBP-5:** Use natural and unadulterated building materials that preserve the natural and beneficial DC electric field (air ionization) and the DC magnetic field.
- **BBP-12:** Provide an abundance of well-balanced natural light and illumination while using color in accordance with nature.
- **BBP-19:** Minimize indoor interference with vital cosmic and terrestrial radiation.
- **BBP-20:** Minimize man-made power system and radio frequency radiation exposure generated from within the building and from outside sources.
- **BBP-21:** Avoid use of building materials that have elevated radioactivity levels.
- **BBP-22:** Construction materials production and building processes shall provide for health and social well-being in every phase of the building's life-cycle.





## Healthy Radiant Heating

Building Biology Archive

### Associated Online Course

[IBE 222.7](#)

Radiant heat warms the building, materials, and contents. It does not warm the air itself. Radiant heat is the more biologically preferable and energy efficient methodology for heating an indoor space. There is a reason that we enjoy standing in front of a sunny window in winter, and feeling the warmth of radiant energy from the sun. Radiant heating sources within a house provide a similar comfort, in that they directly heat the body, rather than the air around the body.

**Radiators:** Historically, radiators are the most common form of radiant heat, but they can be costly to install and repair due to lack of knowledge by modern forced air furnace technicians. Newer European designs (i.e. radiant towel racks) are more efficient and have smaller clearance. When properly installed, they should last for decades. The primary downside to radiators is they take up floor space, typically underneath windows. Decorative covers do exist, if so desired, to conceal the radiators, or to make a flat usable surface on top. The covers, however, should allow proper ventilation for the radiator out the top. Radiators are placed in front of windows to create a curtain of heat that protects the comfort of those inside the room, and to reduce the cooling effect that the glazing has upon the space.

Radiant heat is biologically preferred for humans. For most of history, we have gained our thermal comfort from our favorite radiator—the sun. Within a house, radiant heat is far more efficient than forced air systems, which primarily heat the air itself, not the objects and surfaces inside. Our bodies function and respond better to an increase in surface temperature versus an increase in air temperature. Imagine sitting outside on a warm rock on a cool day. We experience more comfort in warmer materials and cooler air. When we try to heat the air and not the contents, it is far more difficult to reach an ideal temperature. With radiant heat, our thermal comfort range is increased, and therefore our well-being is improved. Studies have also shown that we can in fact lower the overall temperature of the space with respect to air temperature when the surfaces are warm. This in turn improves the energy efficiency of the space, as the thermostat can be set at a lower point than if using a forced air system, ultimately maintaining optimal comfort while saving money and the environment.

Although not as efficient as larger radiators, baseboard radiant hot water heating can be used successfully in residential applications. Radiant wall heating, although not common in North America, is a dynamic heating strategy and is the best solution for reducing air stratification. Loops of water are installed directly into the wall system and then plastered over. Some locations even have ceiling loops, but this would only be required in a situation with multiple source radiant heat, such as in a spa room.

**Radiant Floor:** Radiant floor heating is becoming more common in North America. Loop distance (or the spacing between rows of tubing) is determined by heat loss calculations, in order to create even heating. Heat loss is calculated based on construction details, such as insulation, window sizes, amount as a percentage of wall area, and locations. This accurate energy representation can be modeled to determine the best layout. Typically, the spacing between rows of tubing is approximately 6–8 inches apart. (Heating the water/glycol used in radiant heating will be discussed in the Hot Water section of the course).

**Controllers:** A variety of tubing can be used for radiant floor heating, including copper, cross-linked polyethylene and synthetic rubber. Radiators typically have copper tubing. Water with glycol (a food-grade antifreeze) circulates between the tubing and the boiler. For radiant floor heating, various zones are typically set up in a “home-run” style of manifold. Each section, or zone, of the home is on a separate loop, which begin and end at the manifold in the utility room. The spaces that require different heat requirements each have their own zone, which is independently controlled at the manifold for temperature settings. For example, the bedrooms can be cooler, the bathroom warmer, and the living spaces somewhere in the middle.

Typically, thermostats for each zone control a manifold and are set at the desired temperature for the room or rooms controlled by it. This set-up allows for adjustments in the various zones without affecting other areas of the home. Programmable thermostats can automatically turn the zones off and on according to the occupant’s daily routines to maximize efficiency. Circulation pumps can be either AC or DC depending on electrical needs and the homeowner’s sensitivities. If the home has a properly designed passive solar arrangement with thermal mass in the radiant floor, circulation pumps can be run independently of the boiler so that the heat energy stored in the slab through passive gain can be moved to other parts of the building through the radiant floor system.

From a Building Biology perspective, the use of radiant floor heating may not be desirable, since the movement of fluid underneath occupants can create a biological impact similar to naturally-occurring water under buildings. Because of this, Building Biology does not recommend radiant floor hydronic (water) heating. If the installation cannot be altered, consider running the pumps during periods when occupants are not present. Due to the fact that the system heats up the largest thermal mass in the house—the slab—it will retain its heat for hours, even in severe climates. Consequently, the heat may only need to be circulated while occupants are away from the home, in order to provide comfortable heat while reducing occupant exposures.

*Note: Radiant floor or wall electric heating is also available, but because this method also bathes the space in artificial electromagnetic fields, it is not endorsed by Building Biology.*

# Microsurge Electrical Pollution (Dirty Electricity)

Sonia Hoglander, BSSE, MBA, BBEC, EMRS

## Associated Online Course

[IBE 221.2](#)

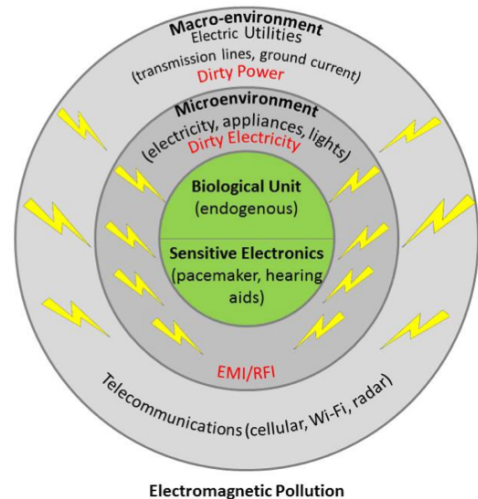
This course is an extract and elaboration on this topic from the IBE Electromagnetic Radiation course series. This course is intended for the greater public interested in having a better understanding of electromagnetic pollution. It attempts to be simple enough to allow people learning about the topic for the first time to become conversant about it and yet technical enough to overcome skepticism.

Overall, this course takes a historical perspective.

Though dirty electricity has been with us since the late 1800s it was not recognized as a problem until the late 1900s. Thanks to pioneers in the field we now have a unified voice on the subject. The course discusses the science, dirty electricity-specific health studies, and measurement and mitigation solutions. Dirty electricity is a ubiquitous problem in modern civilization. It is present everywhere, inside and outside the home. Major sources are utility power, switch mode power supplies (SMPS) used in electronics, AMI meters (due to conducted high-frequency pulsed radiation), Energy efficient lights with a SMPS, variable speed motors in "smart" appliances, PV (Solar) system invertors and utility ground current (especially rural areas). Initial epidemiological studies and case studies indicate cause for concern and need for further study. It has been shown that body voltage and body amperage (induced current) increase in its presence. Dirty electricity is linked to cancer, heart disease, diabetes, obesity, Alzheimer's, multiple sclerosis, ADHD, asthma and just irritation. Applying the precautionary principle is warranted, especially with our most vulnerable populations: children, pregnant women, elderly, electromagnetic-sensitive people, and people already infirmed.

Building Biology consultants holistically evaluate the electromagnetic environment and measure high-frequency radiation, magnetic fields and electric fields including microsurge electrical pollution—MEP (dirty electricity). Wiring errors are a common problem in U.S. homes, which cause excessive magnetic fields and preclude the use of plug-in filters until the errors are fixed. In-side-the-house filters are the last step to cleaning up a polluted electromagnetic environment.

Replacing MEP generating or unplugging devices while not being used is the first step. As a society, we should insist on systemic solutions to the existence of dirty electricity in our environment; built-in filters for appliances and electronics, upgrades to building and electrical codes to install shielded wiring, building power supply line filters and better monitoring and mitigation of ground current.





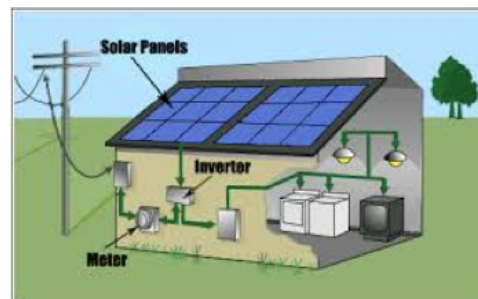


## Photovoltaic Systems

Lawrence Gust, EE, BBEC, EMRS  
Spark Burmaster EE, BBEC, EMRS  
Sonia Hoglander, BSSE, MBA, BBEC, EMRS  
Christopher Bell, BBEC

### Associated Online Course

[IBE 221.5](#)



Electromagnetic Radiation Exposure Solar or Photovoltaic (PV) power generation systems as well as other alternative energy producing systems (e.g. wind generators and gas power, on-site generators) are not recommended for people who are experiencing electromagnetic sensitivity and especially for people displaying the symptoms of Electromagnetic Hyper-Sensitivity (EHS).

People without symptoms are cautioned to evaluate all the pros and cons before moving ahead, especially as pertains to the generation of unwanted EMF radiations and effectiveness of filtration included by various inverter manufactures for reducing with these unwanted radiations.

Can photovoltaic installations have negative health impacts? This question is often asked by people who want to practice sound ecological citizenry and who also care about the health of their family. While the negative impact of some common chemicals is at last widely recognized and popular green certifications now reward or demand reduction of damaging chemicals, there is very little discussion about the harmful effects of man-made electrical radiation or measures that can be taken to reduce exposure.

There is a fast-growing segment of the population who feels ill from our ever-increasing use of electricity and wireless devices. The number of people with EHS has been estimated to have increased ten-fold in the last ten years to 35% of the population. While government agencies, some medical associations, and power companies deny the existence of any health threat, the people who are suffering seek safety and relief. Others who are not affected may be wise to employ a precautionary stance, knowing that what overtly harms some may also have negative impacts for all in the long run. And, indeed, science now has shown a cell level effect from man-made EMR that seems to affect all biological beings whether symptomatic or not.

The Building Biology Institute (IBE) has long specialized in measurement and remediation of electromagnetic radiation (EMR). It offers comprehensive beginning and advanced training on EMR. Below is a summary of a more extensive six-page paper on the electromagnetic radiation issues associated with residential solar electricity systems. Photovoltaic systems can have detrimental health effects due to the following issues:

**Electrical Noise:** The Inverter injects electrical “noise” called Dirty Electricity into house electrical circuits and devices that can be irritating to sensitive people; even people who have not been conscious of sensitivity in the past could experience discomfort. People have reported symptoms of nausea, headaches, and fatigue.

**High Magnetic Fields:** PV systems as well as other alternative systems can be cause unwanted, current flow on your house grounding system as well as neighboring houses. This can cause high magnetic fields in the living space depending on electrical system specifics. This current flow carries pulses made by the inverter that produce symptoms in some people.

**Radio Frequency Radiation:** Wireless (through the air) communication is frequently part of an additional system for billing and equipment monitoring. This is EMR in the microwave or radio frequency range of the electromagnetic spectrum. It’s termed Radio Frequency (RF) radiation. The American Academy of Environmental Medicine, released a letter in January 2012 to the Public Utilities Commission of California speaking to this radiation. The most important passage is: “Chronic exposure to wireless radio frequency radiation is a preventable environmental hazard that is sufficiently well documented to warrant immediate preventative public health action.”

Symptoms from EMR exposure can include but aren’t limited to nausea, headaches, fatigue and sleep disturbance, irritability, skin problems, dizziness, visual, mental confusion and hearing disruptions like tinnitus. These issues of microwave radiation, dirty electricity and grounding system currents are complex and are difficult to mitigate. More details available at this link: [Photovoltaic Electrical Systems](#).



## Subtle Energy Devices:

Building Biology Archive

### Associated Online Course

[IBE 221.2](#)

Subtle energy devices are defined for the purpose of this position statement as chips, pendants, harmonizers and the like that claim to mitigate the reaction of a human being to man-made electromagnetic radiation (EMR), but do not alter the readings shown on meters designed to measure the type of radiation in question.

We are concerned about the possibility that with long term experience these devices turn out to mask growing physical problem or grow less effective over time. We are willing to allow that the improvements reported by people who use these chips may have a basis in fact, as indicated by such evidence as reduced clumping of red blood cells in live blood cell analysis, reduced tissue heating in thermography, and reduced DNA damage in rats.

If the results are true, then there must be a biological basis for these changes. The limited research, coupled with thousands of testimonials support the idea that there is some efficacy to some of these devices. Yet, such devices, if they work, seem to elicit different responses from different people. Some people seem to be helped; some are not helped. The reasons for this are unknown. However, since some people are helped by some devices, we support their use under certain conditions.

## **Conditions for Use**

- Do not use subtle energy devices as a sole means of protection, or even as your first line of protection.
- Use them as supplemental protection against electromagnetic radiation in situations where it cannot be avoided. Use them as an adjunct to EMF reduction/elimination strategies in your living and work spaces, particularly for people with electrical sensitivity.
- Put into practice methods that will eliminate or reduce exposure to electromagnetic radiation in spaces that you control.

## **Radio Frequency (RF) EMR Pollution**

Follow the principles of reduced use and increase distance. Use a hands-free device for your cell phone. Keep your telephone landline. Use a corded telephone and give your land line number to your friends and family and tell them to call that number first. Use your corded landline telephone to make all outgoing phone calls. Call forward your cell phone to your land-line when you are at home and shut off your cell phone or put it in airplane mode. Don't use a wireless Internet connection (Wi-Fi or Airport). Convert your Wi-Fi into a hardwired local area network (LAN) in your home using Ethernet cables. Then disable or turn off the Wi-Fi on your router and laptop. Avoid using iPads and other tablets wirelessly. Although these devices do not have an Ethernet jack, there is a proven work-around for iPad and iPhone and a possible work-around for Android devices.

## **Electrical System EMR Pollution**

Have your home evaluated and mitigated for Electric Fields and Magnetic Fields. It is particularly important to get the EMR from all man-made radiations including electric fields, magnetic fields and RF, evaluated and reduced where you sleep. If excessive EMR is identified you may need to fix wiring errors and clear current on the grounding system, including water pipes, cable TV and phone line.

## **Conclusion**

These are the steps you can and should take to protect yourself by measurably reducing the overall toxic load created by man-made EMR exposure. This is to be done in those places you have control over, primarily, your home. Additionally, it makes sense to use subtle energy devices for the protection they offer when you are away from home and as an additional approach when you are in spaces that you control. Please don't assume that with subtle energy devices you are fully protected. There is no research showing long-term efficacy. However, we know there is long term efficacy when man-made radiation is eliminated or drastically reduced.

09 June 2015



## "Smart" Meters

Larry Gust, EE, BBEC, EMRS

Sonia Hoglander, BSSE, MBA, BBEC, EMRS

### Associated Online Course

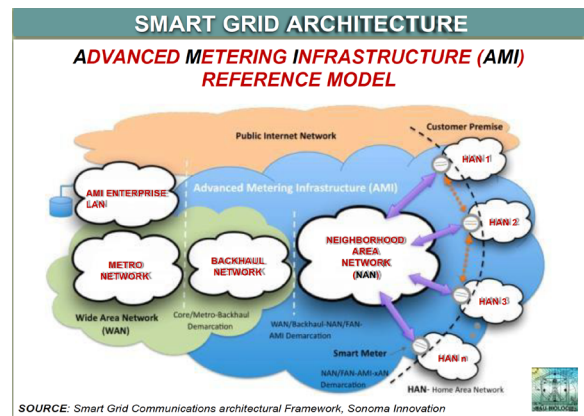
[IBE 221.3](#)

"Smart" meters do not satisfy International Institute for Building Biology & Ecology's (IBE) standards for a healthy built environment. The primary problems are the wireless communication with high frequency electromagnetic radiation and the disturbing peculiarity of the transients added to the house wiring called electromagnetic interference (EMI). Utility meters are used to measure consumption of commodities such as water, gas and electricity. Utility meters that measure electricity consumption operate by continuously measuring the voltage and current consumed to calculate energy in kilowatt-hours for which you are billed.

Gas and water meters measure flow rates. Meters fall into two basic categories, electromechanical (also known as analog) and electronic. The electronic or digital utility meters have been around since the early 1990's. The first remote communicating electric meters, AMR (Automated Meter Reading) meters, started replacing the traditional analog electric meters in the middle to late 1990's, a patent for the technology was filed in 1997. Some analog meters were modified with a transmitting device making them hybrids. The electricity "smart" meter is technically known as an AMI (Advanced Metering Infrastructure) meter and started rolling out in the early 2000's. The key difference of the AMI meter is its two-way communication capability; it can receive data as well as transmit it. The AMI can be a wired network but that is not what utilities around the world are using; preferring the easier, cheaper wireless option. Other potential problems inherent with the AMI meters are increased fire risk, increased electricity bills, breached privacy, shorter technology life span, and security. It is highly probable digital meters ("smart" meters), whether AMR, AMI or noncommunicating, are an assault on the biology and ecology of all living organisms.

Extensive research by technical experts has shown no benefit to consumers from electricity smart meters. Digital smart meters are a high cost, environmentally unsustainable way to automate meter reading. We have yet to know conclusively the long-term impact on biology or ecology, but the evidence is increasingly indicative of cumulative harm. The high intensity, pulsed radiation and potentially unique EMI from digital meters is an incremental increase on top of an already saturated EMF environment from the proliferation of cell phone technology (phones and antennas), available anywhere Wi-Fi, and a proliferation of wireless devices in the home. This level will increase as we enter the era of the Internet of Things (IoT) with Fifth Generation (5G) cellular technology.

*IBE does not support deployment of "smart" meters. Digital meters fail to meet several of our principles of a healthy and sustainably built environment. Number one among them is the "precautionary principle" related to possible health and ecology impact. We recommend, especially for people experiencing EHS, to opt-out of AMI systems and to request retention or reinstallation of an analog electric meter whenever possible. When opting out is not possible, we recommend the use of shielding strategies.*







## The Human Response To Light

Anja Schiller, B.S. Plant Ecology, BBEC, EMRS

### Associated Online Course

[IBE 221.12](#)

Light is a central part of the human experience. Not only does light allow us to see but also our exposure to light largely determines our physiological, and in turn psychological, functioning. The majority of organisms on the planet, including humans, have developed finely tuned circadian clocks synced to Earth's light-dark cycle. In addition, we synthesize vitamin D and other important compounds when our skin is exposed to sunlight. Altering our experience of the natural light-dark cycle by adding artificial light at night and spending the majority of our daytime hours indoors can have serious health consequences. Many of our modern lighting sources differ in their spectral qualities compared to natural sunlight and also come with an electromagnetic radiation and hazardous material burden (see course Electric Light: Options & Health Impacts). This course will cover the human visual, circadian, and skin responses to both natural and artificial light as well as daylighting strategies to bring natural light into buildings.

What is light? Light is electromagnetic radiation. Visible light is generally defined as the part of the electromagnetic spectrum that is detectable by the human eye. It is divided based on wavelengths that appear as different colors – red, orange, yellow, green, blue, indigo, and violet; with red having the longest and violet the shortest wavelengths. The spectral regions adjacent to visible light are also often referred to as light. These are infrared (IR) on the one end (longer waves) and ultraviolet (UV) on the other end (shorter waves). It is important to note, that shorter wavelengths of light contain more energy, which have the potential to be more biologically harmful than longer wavelengths.

Light (visible, UV, and IR) is essential to life on Earth and is an integral part of the human experience. Our understanding of how the human body responds to light is constantly growing and evolving. There are three main systems in our bodies that utilize light:

1. The Visual System – for vision
2. The Non-Image Forming System – for circadian rhythm regulation
3. The Skin System – for synthesis of vitamin D and other compounds

## **Light and Vision**

Light allows us to see. What we see and how we process it largely determines how we move about, our ability to perform tasks, how we relate with others, and the decisions we make. However, light can also damage our eyes. Prolonged exposure to high intensity or high energy (i.e. short wavelengths like UV and blue) light at certain levels can cause oxidative stress in our eyes, break down pigments, and even cause the death of photoreceptor cells.

Many modern light bulbs have a strong blue light component. Cold white LEDs with a high correlated color temperature (CCT)<sup>1</sup> can have 3-4 times the blue light energy of warm white LEDs with a low CCT. Thus, high CCT LEDs pose an elevated risk for eye toxicity. Light from screens on TVs, computers, and mobile devices tends to peak at the blue wavelengths and has been shown to cause oxidative stress and death of eye cells. It is, therefore, recommended to use neutral to warm light sources and/or blue-blocking apps on devices.

## **Light and Circadian Entrainment**

Virtually all organisms have developed an internal time-keeping system, a circadian clock, in response to the natural 24-hour light and dark cycle of our planet. Environmental stimuli that can alter the circadian rhythms of our bodies are called Zeitgebers, literally “time-givers” in German. Although there are a number of Zeitgebers, including temperature, meal-timing, exercise, and even social interaction, light is the most important.

In nature, transitions between light and dark are gradual and consistent. Today, we can alter our light environment with the flick of a switch. Many people are now spending the majority of their time indoors with little exposure to natural light during the day and excessive levels of artificial light at night. We are essentially self-selecting our light-dark cycles. This mal-alignment disrupts our circadian rhythms, which leads to a cascade of health issues largely through the disruption of melatonin production.

Melatonin is a key component of our sleep-wake cycle. When we are exposed to light, our body turns off melatonin production, making us feel alert. Alternatively, when it is dark, our body turns on melatonin production, which makes us feel drowsy and prepares us for sleep. Artificial light at night disrupts the natural rise of melatonin at dusk making it harder for us to get to sleep and to reach deep sleep. The suppression of melatonin from artificial light at night, however, is harmful at a much greater level than through its impact on sleep. Melatonin is one of the most powerful antioxidants in our bodies and low levels have been linked to a large variety of health issues including cancer, diabetes, and cardiovascular disease. In general, melatonin suppression increases with increasing light intensity, that is, the brighter the light, the stronger the effect. Studies suggest that around and after sunset, we should limit our light exposure to 30 lux or less. Melatonin suppression is also greatest at the short wavelength

colors—blue and violet. In fact, monochromatic blue light as low as 1 lux can suppress melatonin production.

Cold white light bulbs, especially LEDs, with a high CCT generally contain high levels of blue light. Screens are another significant source of blue light. Their use at bedtime effectively suppresses melatonin levels, and delays and disrupts sleep. It is recommended to use warm light sources, blueblocking glasses, and/or blue-blocking apps on devices from around sunset. Avoiding inappropriate light at night is only part of the story. The flip side is that daytime exposure to bright blue-rich light is equally important for our circadian entrainment. Unlike our ancestors, most of us spend the majority of daylight hours indoors with light levels that are much dimmer than outside. Outdoor light ranges between 1000 lux close to sunrise and sunset and on a cloudy day, and 100,000 lux or more in the middle of a sunny day while light levels tend to be around 50-100 lux in homes and 100-500 lux in offices. Research suggests that at least 1000 lux is needed for optimal melatonin suppression during the day.

*Note: Although midday sunlight contains blue light, it is balanced with other colors and does not pose the same eye risk as blue-dominant electric light sources.*

## **Light and Skin**

Skin, the body's largest organ, is our main interface with the external environment. It senses, responds to, and protects against the elements, including pathogens, toxins, and solar radiation. The cells in our skin respond to light in a multitude of ways, many of which we are still learning about.

The synthesis of vitamin D in the skin is the most well-studied light activated pathway. Vitamin D is often referred to as the sunshine vitamin because it is synthesized in the skin when exposed to sufficient levels of UV. Vitamin D is important to all systems in our bodies including the neurological, cardiovascular, and immune system. In recent years it has been discovered that every tissue and cell in the human body has vitamin D receptors. Once inside a cell, vitamin D can regulate the expression of over 2000 genes. Deficiency of vitamin D has been correlated with a long list of health conditions including many cancers, diabetes, and even multiple sclerosis.

We need surprisingly little time in the midday summer sun to produce our daily needs—about 20–30 minutes for light-skinned individuals. However, much of the population is vitamin D deficient. This is largely due to the fact that the average North American spends around 90% of their day indoors. Also, at higher latitudes, ambient UV levels are not high enough for vitamin D synthesis during the winter. The app dminder (<http://dminder.info>) helps people get sufficient sun exposure for vitamin D production by taking into account location, weather, skin pigmentation, and the amount of clothing someone is wearing.

How the skin responds with UV is complicated. We need a certain amount for vitamin D production. However, too much UV can cause damage to our skin cells to the point of sunburn. History of severe sunburn, especially when young, is the number one risk factor for melanoma, the dangerous type of skin cancer. But before we reach sunburn state, our skin is

stimulated by UV exposure to produce melanin. Melanin acts as a natural sunscreen and also as a strong antioxidant that inactivates cancer-causing free radicals. Thus, some UV is very important for our health but too much is harmful. The dminder app can be useful here too by giving warnings of sunburn risk. It is important to note that tanning beds are associated with an increased risk in all types of skin cancer. This may be due partly to the type of UV they emit being different and more intense to that of sunlight and also the high levels of electromagnetic radiation from the UV lamps. Overall, it is recommended to get sensible sun exposure that avoids sunburns.

## **Light In Building Design**

Given the wide-ranging benefits of sunlight to our health, and that most people now spend the majority of their time indoors, it is important to design buildings that maximize appropriate natural light. This practice is called daylighting. An additional benefit of daylighting is the reduction of artificial lighting needs during the day, which can lower the overall energy consumption of a building if thermal aspects are also carefully considered in the design. Natural light can be brought into a building by creating apertures such as windows and clerestories on side walls, called sidelighting or from above with skylights and light pipes, called toplighting. Windows with glazing that changes the spectral distribution of the incoming daylight as little as possible are the healthiest option but low-e coatings may be considered to prevent heat loss or gain.

Other techniques that help bring natural light into buildings include light shelves and fiber optics. In addition to lighting qualities, the placement of windows should consider the ability to provide a view to the outside, which is also important to occupant well-being.

## **Phototherapy**

Light, natural or artificial, can be used as a therapeutic treatment for physical and/or mental illness. Sunlight has been used therapeutically historically – 3,500 years ago for skin lesions by the Egyptians, and in the early 1900s for rickets and tuberculosis. Today, artificial light (lasers and LEDs) is used medically to resolve many conditions such as dermatological diseases, depressive disorders, and neonatal jaundice. Sauna, infrared radiation, also has been shown to have healing properties—improving cardiovascular health, mental wellness, and aiding in detoxification. Thus, light, in many forms, can be used as a tool for healing.

Healthy lighting for humans and the environment involves not only which lamps we choose, but also our habits, and can include building design. Building Biology takes a holistic approach that looks at all aspects of lighting, natural and artificial, concerning the health of humans and the environment.

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1 Correlated color temperature (K) is a general measure of the “warmth” or “coolness” of white light. Opposite to the temperature scale, warm lights that appear yellowish have a low CCT (< 3000 K) and cool lights that appear bluish have a high CCT (> 5000 K).



## Why Create a Sleep Sanctuary?

Building Biology Archive

### **Associated Online Course**

[IBE 221.7](#)

The human body is an amazing, self-rejuvenating system that has the ability to repair itself during sleep. The body's own internal electrical system functions via electrical impulses that are generated by the brain and used for intercellular communication. Physiologically, the body is composed mainly of water with a high mineral content, which makes it very electrically conductive.

Every cell in the body knows when to divide by vibrating. Brain cells, nerve cells, and bone cells all vibrate at different rates in order to communicate with one another. In the typical sleeping area, electrical exposures from external sources (i.e. live electrical wiring in ceilings, walls and floors) is thousands of times stronger than the body's own electrical system. Long-term exposure to these high-level electric fields can impair the body's ability to communicate with itself, and thus negatively impact a person's health. The average person spends approximately one-third of their life sleeping. Doesn't it make sense to reduce exposure to electric fields in our sleeping areas?

For some people, long-term exposure to elevated levels of electricity at night lead to physical symptoms such as: headaches, hyperactivity, nightmares, depression, fatigue, eyestrain, and muscle cramps. Biological problems associated with electromagnetic stressors fall into two primary categories:

1. Brain (behavioral abnormalities, learning disabilities, altered bio-cycles and stress responses)
2. Growing tissue (embryos, genetic material and cancer)





### **5 Easy Steps to Creating a Sleeping Sanctuary**

1. Use battery-powered clocks near the bed: Many electric clocks produce high magnetic fields. Research has shown that exposure to high magnetic fields while sleeping can cause severe chronic illness.
2. Turn off bedroom-affecting electrical circuits: A restful sleep is necessary for good health and a strong immune system. Electric fields affect the body's biocommunications, preventing a person from sleeping soundly.
3. Eliminate, minimize, or shield Radiofrequency (RF): Radiofrequency signals from portable phones, cell phones, and wireless devices have been shown to interfere with the body's immune system.
4. Use beds without metal: Metal frames and metal box springs can amplify and distort the earth's natural magnetic field, which can lead to non-restful sleep. Use natural materials for mattresses and bedframes instead. Natural materials for mattresses include organic wool and natural latex. Wooden bed frames are beautiful and durable.
5. Make sure there are no elevated magnetic fields: Magnetic fields from appliances and building wiring can penetrate walls into a bedroom and disrupt the body's communication system.

Newborns and children are more vulnerable to electromagnetic stressors due to their thinner skulls and undeveloped immune systems. The information and solutions presented in these videos apply to adults, newborns, and children.



## Sleep Better Without Metal

Melody Chan Graves, BBEC

### Associated Course

[IBE 221.7](#)

In this hurry-up-and-go society, we tend to take our bodies for granted, pushing them to the limit with stress and long hours, feeding them unhealthy caffeine and energy drinks, and spending too little time sleeping.

What precious time you spend in your bed should be restful. But what most people don't know is that your mat-tress has a lot to do with how well you sleep at night, and for a very different reason than you might think—magnetic fields.

A large percentage of the population sleeps on traditional innerspring mattresses with a box spring. Even though you might have gotten a new mattress and the support and firmness feels just right, if you're using a mattress with metal in it, and especially if you use it conjunction with a metal box spring and bed frame, you may be subjecting yourself to very strong static magnetic fields at night. Why? Because the coils inside mattresses tend to become magnetized with the normal movements of sleep. And once they become magnetized, they are likely to stay that way.

Why is magnetization harmful? Just like any other high-precision piece of electrical equipment, like computers or delicate audio/visual or medical imaging equipment, the human body relies on electrical impulses to communicate on a cellular level.

When the body is exposed to strong magnetic fields, cellular communication can be interrupted or interfered with, much like a magnetic field can cause static on a video feed or unexpected program crashes on a computer. Chronic exposure to elevated static magnetic fields can lead to poor quality sleep, impaired metabolic function, and a host of other illnesses because your body isn't able to repair itself effectively at night.

How can you tell if your mattress is magnetized? Take a liquid-filled compass into your bedroom and hold it away from the bed. Note the position of the needle. Move it to the surface of the bed and see if the needle moves. Deviation from the original reading indicates the presence of a magnetic field. Next, drag the compass lengthwise along the mattress for a few inches. If there is more than 2 degrees shift in either direction, your bed is considered to be magnetized. In extreme cases, deviations of 180 degrees or more can happen with mattresses in combination with a box spring platform. Hollywood-style metal bed frames often intensify this effect.

If your bed shows severe magnetization (10 degrees or more when dragged along the mattress for 3 inches), try to get rid of as much metal as possible. Replace your box spring with a wooden platform and start saving up for an all-natural cotton and wool futon or natural latex rubber mattress. Wooden platforms with slats are the best choice for bed foundations, because they allow for better air circulation underneath the mattress than solid panel platforms.

If these measures seem a little excessive to you, remember that you spend nearly a third of your life in bed. Eliminating strong magnetic fields gives your body a better chance to rest and repair. After a hard day's work, doesn't your body deserve it? Life cycle costs when choosing materials used in construction.



## 25 Principles of Building Biology

### **Site & Community Design**

1. Verify that the site is free of naturally-occurring and man-made health hazards.
2. Place dwellings so occupants are undisturbed by sources of man-made air, soil, water, noise and electro-pollution.
3. Place dwellings in well-planned communities that provide ample access to fresh air, sunshine and nature.
4. Plan homes and developments considering the needs of community, families and individuals of all ages.

### **Occupant Health & Well-Being**

5. Use natural and unadulterated building materials.
6. Allow natural self-regulation of indoor humidity with hygroscopic materials.
7. Assure low total moisture content and rapid desiccation of wet construction processes
8. Climatically balance thermal insulation and thermal storage capacity.
9. Plan for climatically appropriate surface and air temperature.
10. Provide for ample ventilation.
11. Use appropriate thermal radiation strategies for heating buildings including passive solar wherever viable.
12. Provide an abundance of well-balanced natural light and illumination while using color in accordance with nature.
13. Provide adequate acoustical protection from harmful noise and vibration.
14. Utilize non-toxic building materials that have neutral or pleasant natural scents.
15. Use appropriate water and moisture exclusion techniques to prevent interior growth of fungi, bacteria, dust and allergens.
16. Assure best possible water quality by applying purification technologies if required.
17. Utilize physiological and ergonomic knowledge in interior and furniture design.
18. Consider proportion, harmonic measure, order and shape in design.

### **Natural & Man-Made Electro-Magnetic Radiation Safety**

19. Minimize indoor interference with vital cosmic and terrestrial radiation.
20. Minimize man-made power system and radio frequency radiation exposure generated from within the building and from outside sources.
21. Avoid use of building materials that have elevated radioactivity levels.

### **Environmental Protection, Social Responsibility and Energy Efficiency**

22. Construction materials production and building processes shall provide for health and social well-being in every phase of the building's life-cycle.
23. Avoid the use of building materials that deplete irreplaceable natural resources or are being harvested in an unsustainable manner.
24. Minimize energy consumption throughout the life of the building utilizing climate-based and energy efficient design, energy and water saving technologies and renewable energy.
25. Consider the embodied energy and environmental life cycle costs when choosing materials used in construction.

## What is a Building Biologist?

Paula Baker-Laporte, FAIA  
Christopher Bell  
Larry Gust, EE, BBEC, EMRS  
Spark Burmaster, EE, BBEC, EMRS

Our professional certification programs thoroughly equip students with practical, realworld, hands-on experience in identifying, assessing, and mitigating or eliminating pollutants, airborne toxins, and electromagnetic emissions in homes, schools, offices, and commercial buildings. They also become experts in prevention, certified to advise homeowners, as well as architects, builders, inspectors, engineers, and medical professionals in methods and practices that create and maintain an ecological and environmentally healthy home or commercial building. Throughout our training programs we concentrate on teaching them the skills needed to make a genuine positive impact in their communities and in the world at large. Building Biology Professional Certification is a creative education that is pertinent to many disciplines and its graduates include health practitioners, architects, planners, builders, and expert building assessors. It brings together dynamic, visionary individuals to work for a better, more sustainable and truly Green world. The practice of Building Biology is an extraordinary, valued, necessary, and satisfying career. The goals are to:

- **Achieve order and harmony in our surroundings**
- **Forge a balance between nature, our buildings, and ourselves**
- **Foster connections for an ecologically oriented world.**
- **Provide a holistic approach to building with occupant wellbeing as the primary focus.**

A Building Biologist is trained to view the holistic relationship of all life, and become an environmental advocate in the global effort to solve the problems that arise from modern methods of creating the built environment including community planning, buildings and wireless communication technology. Many of these modern “advances” disregard nature and humanity with the result of degradation of our health and the health of the natural environment. By understanding and applying the laws of nature to the built environment Building Biologists are uniquely trained to become leaders in finding the solutions to the problems that modern mankind has created through the misuse of chemistry and technology. Building Biologists strive to change the built world to make it healthier for all. And by setting practical, real-world examples and disseminating solid advice based on Building Biology Principles, they are making positive change.

**To learn more, please visit the certification section of our website:**

[buildingbiologyinstitute.org/certifications/](http://buildingbiologyinstitute.org/certifications/)



## Our Founder

Helmut Ziehe, 1936–2013



Helmut's Building Biology calling began with an "ah-ha" experience in North Africa in 1980 that changed the course of his life and career. As resident engineer for a city of 90,000 inhabitants, he noted that a majority of people had abandoned their government-provided homes in favor of living in tents. Their government homes were constructed of concrete, a poor material health-wise, that heated the interior rooms to an extent that air-conditioning could not bring adequate relief. A seasoned architect with a Dipl.Ing. degree from Technical University of Berlin, and a Master's in Tropical Studies from the London School of Architecture, Helmut unearthed the solution by examining historical

local homes, some of which dated back 4,000 years, and found they used clay for their basic building material, as well as utilized covered walkways for shading and ventilation.

This eye-opening experience led Helmut beyond his career as a modernist architect to embrace the precepts of Baubiologie. Once his engineering assignment in North Africa was completed, he began his studies under Dr. Anton Schneider at the Institut für Baubiologie + Oekologie (IBN), and never thereafter returned to his "conventional" architecture practice. In 1985 he moved to the United Kingdom, where he established the English Institute of Baubiologie, personally translating from German into English twenty-three IBN course packs that became the IBE Correspondence Course for training new Building Biologists. In 1987, he relocated to Clearwater, Florida, establishing the International Institute for Baubiologie & Ecology, which to this day (as Building Biology Institute) serves all of North America, as well as English speaking students and alumni from sixteen (and counting) overseas nations.

In 1989, when a reporter asked Helmut, "How many students does the Institute have?" Helmut answered: "Only eight." To which the reporter replied: "Everyone has to start small." Since that day, the institute Helmut founded has enrolled over 2,000 students.



**Building Biology Institute**  
The science of healthy buildings

[buildingbiologyinstitute.org](http://buildingbiologyinstitute.org)