

There is a hidden danger buzzing behind the walls of millions of homes, schools, and businesses. It cannot be seen or smelled, but compelling evidence suggests it's affecting our health.

What is it?

DIRTY ELECTRICITY

Dirty electricity refers to microsurgers and spikes of energy traveling along power lines, building wires, and power cords where only conventional ("clean") AC electricity should be. It's ONE of five different types of EMF pollution becoming increasingly common in and around homes and other buildings.

DISCOVER MORE in this general *Guide to Dirty Electricity*.



Guide to Dirty Electricity

- **Learn what dirty electricity is and how it's created in homes and other settings.**
(Pages 1 – 7)
- **Find out how dirty electricity in your home may be impacting you and your family's health.**
(Pages 8 – 11)
- **Get basic tips for measuring dirty electricity and identifying sources in your environment.**
(Pages 12 – 19)
- **Explore ways to protect yourself and loved ones against this fast-growing form of EMF pollution.**
(Pages 20 – 39)



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The ideas, opinions, and suggestions presented are not intended to be a substitute for consultation with a qualified health care provider. Please consult your own appropriate health care provider about applicability of any opinions or recommendations with respect to your own symptoms or medical conditions.

Guide to Dirty Electricity

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What Is Dirty Electricity?

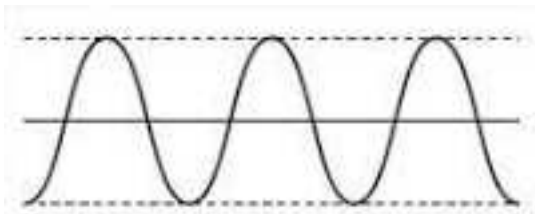
The only frequency of energy traveling through power lines and electrical wiring in buildings should be the smooth sine wave of conventional AC electricity, which oscillates at a frequency of 60 Hertz (Hz) in some parts of the world and 50 Hertz (Hz) in others.

Unfortunately, these days there is often a chaotic mess of HIGHER frequencies (typically with non-sinusoidal wave forms) also flowing through or along power lines, building wires, electrical cords, the ground (earth), and more. These chaotic, higher (non 50/60 Hz) frequencies of energy are commonly referred to as "DIRTY ELECTRICITY."

Dirty electricity is ONE of five different types of **EMF pollution** becoming increasingly common in and around homes and other buildings. It's also known as dirty power, electrical noise, line noise, electromagnetic interference (EMI), radio frequency interference (RFI), power line EMI (or RFI), and microsurge electrical pollution. Technical terms associated with dirty electricity include harmonics (i.e., harmonic frequencies) and high frequency voltage transients. See Appendix A for more information on the different types of EMF pollution.

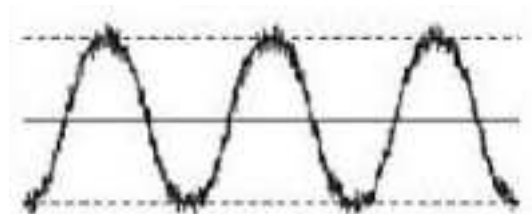
CLEAN ELECTRICITY

Smooth 50/60 Hz Sine Wave



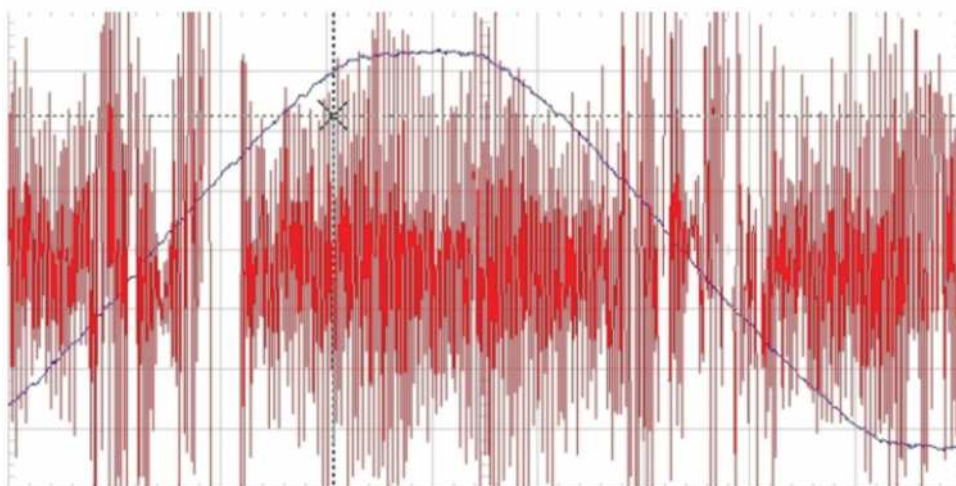
DIRTY ELECTRICITY

Riding "On Top Of" 50/60 Hz Sine Wave



DIRTY ELECTRICITY

Close up as shown on an oscilloscope



How Is Dirty Electricity Created?

Dirty electricity has become increasingly prevalent since the 1980's due in large part to these factors:

- Strong push for energy efficiency in lighting, appliances, and more.
- Growing interest in alternative power sources (e.g., solar, wind) for homes and other buildings.
- Increased use of equipment, appliances, and other devices with switch mode power supplies and variable speed motors or drives.

Unlike older devices, LOTS of modern devices do NOT use conventional 50/60 Hz AC electricity *AS IS*, or in other words, in the exact form it's provided to us by utility companies. Instead, they must change or manipulate aspects of conventional electricity (i.e., voltage and/or electrical current) in one way or another to operate. *See examples below.*

Common Ways Modern Devices Change or Manipulate Electrical Current and Voltage
Convert AC electricity (alternating current) to DC electricity (direct current) to run.
Change standard electrical voltage (120 Volts or 220-240 Volts) to one or more lower or higher voltages to run.
Draw power in small pulses (or bits) rather than as a continuous stream. (Do this by turning the flow of electrical current ON and OFF repeatedly, often thousands of times per second.)

Changes and manipulations like those described to the left "chop up" and distort the smooth sine wave of conventional electricity, causing lots of interruptions in the smooth flow of electrical current. It is these interruptions that produce DIRTY ELECTRICITY, or in technical terms, the microsurgers and spikes of current and voltage known as harmonics and high frequency voltage transients.

- **Harmonics**
Multiples of the fundamental 50/60 Hz frequency of electricity (e.g., 100 or 120 Hz; 150 or 180 Hz; 200 or 240 Hz; 250 or 200 Hz; etc.)
- **High Frequency Voltage Transients**
Distortions (spikes) in the voltage waveform caused by momentary changes in the electrical power supplied to a circuit.

Dirty electricity SPREADS!

Once produced, dirty electricity “spreads.”

- Some dirty electricity radiates directly into the air from the devices that create it.
- Most is conducted back up the power cords of these dirty electricity sources (e.g., equipment, appliances, and other devices), where it can then spread throughout a building via the electrical wiring in walls, ceilings, and floors.
- Dirty electricity can also flow up and down the cords of other appliances and devices plugged into electrical outlets.
- It can even move from one home or building to others via power lines and other means (e.g., metal water pipes, grounding conductors, the earth).

As dirty electricity flows along cords, building wires, power lines, and more, it radiates potentially harmful electromagnetic fields (EMFs) into rooms and other spaces where people spend time.

The AC electric and magnetic fields associated with dirty electricity are chaotic and noisy in nature, containing many high frequency components often in the radio frequency (RF) range of the electromagnetic spectrum.

It is common these days for there to be dirty electricity from multiple sources at many different frequencies flowing through building wires simultaneously (i.e., piggybacked “on top of” conventional AC electricity).



Up and Down Power Cords
(plugged into outlets)



Via Electrical Wiring
(in walls, ceilings, and more)



Via Power Lines
(from one building to another)

And MORE!

Common Sources of Dirty Electricity

The list of equipment, appliances, and other devices that produce dirty electricity seems endless. Nearly anything we plug in and turn ON today has the potential to generate this type of EMF pollution. This is particularly true of devices that are energy efficient, include a switch mode power supply, and/or have an electric motor (especially a variable speed motor/drive). The box to the right shows examples of common dirty electricity sources in homes and other settings. This list is NOT exhaustive!

It is important to note that the dirty electricity flowing along the wiring in your home (and other buildings) often comes from a combination of both INTERNAL (inside) and EXTERNAL (outside) sources.

Dirty electricity from INTERNAL sources is created by electric and electronic equipment, appliances, and other devices operating **inside** your own environment.

Dirty electricity from EXTERNAL sources is generated in other homes and buildings and by infrastructure such as cell towers, that run on electricity. It can find its way "onto" your electrical wiring and other "unwanted" places (e.g., metal water pipes, grounding conductors, etc.) via power lines and other means.

This is essential to understand. It means that even if you have no dirty electricity sources in your own home (which would be difficult these days), you can still have dirty electricity from external sources "invading" your electrical circuits and more.

For example, people who have neighbors with PV solar power systems often have high levels of dirty electricity riding their own wiring, even when they don't have a solar power system or other big dirty electricity sources themselves.

COMMON SOURCES

- Light dimmer switches
- Energy-efficient light bulbs (e.g., CFLs, low voltage halogen bulbs, "dirty" LEDs)
- Cordless telephones
- Computers
- Internet routers
- Printers, scanners, and copy machines
- Smart TVs
- Video game consoles
- Music entertainment systems
- Battery charging devices (e.g., for cell phones, tablets, LED flashlights, etc.)
- High efficiency HVAC equipment
- Pool and well pumps
- Dishwashers
- Microwave ovens
- Refrigerators and freezers
- Equipment/appliances with digital display screens (e.g., stoves, ovens, dishwashers, etc.)
- Mixers, blenders, and juicers
- Washing machines and dryers
- Air filters and multi-speed fans
- Sewing machines
- Vacuum cleaners
- Hair dryers
- Electric power tools
- Smart utility meters and appliances
- Solar and wind power systems (inverters)
- Electric car charging stations
- Cell towers (because they run on electricity)
- Some industrial equipment
- And MORE!



Are Dirty Electricity and Other EMF Pollution Making Us Sick?

Dirty electricity in homes and other settings is much more prevalent now than it was just 20 or 30 years ago. Unfortunately, our exposures to this type of EMF pollution are likely to continue growing as our use of modern electronics, energy-efficient equipment and lighting, solar power, and many other sources increases. So, is this a problem? Should we be concerned? The answer seems to be, YES!

First, dirty electricity flowing through building wires can meddle with electronic equipment and appliances, making them less efficient and interfering with their proper performance. It can even shorten the lifespan of some sensitive equipment. Less efficient equipment and shorter lifespans can mean higher power bills and more frequent replacement costs.

More concerning, though, are the potential effects that dirty electricity and other forms of EMF pollution can have in our bodies and for our health. A growing body of scientific and clinical evidence points to concerning connections between EMF pollution (artificial electromagnetic fields/radiation) and a wide variety of biological effects and health problems. (See examples to the right.)



In 2007 and again in 2012, an international group of scientists and public health experts from around the world released a detailed document (i.e., The Bioinitiative Report) describing detrimental effects of electromagnetic fields (EMFs) from all sources. In this report, the scientists cited thousands of research studies and concluded that chronic exposure to radiation associated with EMF pollution can weaken our immune systems, increase our risk of a variety of cancers, and contribute to heart disease, dementia, and many other health problems.

Biological & Health Effects Associated with EMF Pollution
<ul style="list-style-type: none">• DNA damage• Oxidative stress• Mitochondrial dysfunction• Inflammation• Reduced melatonin production• Leaky blood brain barrier• Cancer• Heart problems (e.g., palpitations, arrhythmias, chest pain/pressure, cardiomyopathy, sudden cardiac death)• Diabetes• Alzheimer's, dementia, and memory loss• ALS (Lou Gehrig's disease)• Autism• ADD/ADHD• Infertility• Insomnia and other sleep problems• Chronic fatigue• Mental confusion – brain fog• Headaches and migraines• Muscle and joint pain - fibromyalgia• Tinnitus (ringing in the ears)• Burning, tingling, and pricking sensations• Dizziness, vertigo, and nausea• Asthma and allergy symptoms• Mood issues (e.g., restlessness, irritability, anxiety, depression)• And more!

Dr. Samuel Milham, a noted physician-epidemiologist, spent nearly 30 years researching the impact of electricity and EMFs on health. In his book, *Dirty Electricity: Electrification and the Diseases of Civilization*, Dr. Milham points to clear links between EMF exposure and twentieth century diseases of civilization, including cancer, cardiovascular disease, diabetes, and suicide. He also believes that dirty electricity and other EMF pollution may contribute to the development of Alzheimer's disease, multiple sclerosis (MS), amyotrophic lateral sclerosis (ALS or Lou Gehrig's disease), infertility issues, and other health problems. He has urged for more scientific research to further investigate these connections.

Other researchers and clinicians have also observed associations between dirty electricity and major twentieth century diseases and other ailments, including asthma, behavioral problems, ADD/ADHD symptoms, sleep disturbances, headaches, chronic fatigue, muscle and joint pain, fibromyalgia, and mood issues such as depression, anxiety, and irritability.

Cancer and Dirty Electricity

Evidence is mounting that EMFs associated with ELECTRICITY are contributing to an increase in cancer rates and cancer clusters. A majority of research in this area has focused on the health impacts of the 50/60 Hz magnetic fields associated with "conventional" electricity. These magnetic fields have been linked to a variety of cancers, including childhood leukemia, brain tumors, and breast cancer among others.

Now there is evidence that dirty electricity may also cause cancer. While research on dirty electricity and cancer is still young, the results are startling. Of particular interest is a study by Dr. Samuel Milham (mentioned previously) and Lloyd Morgan, a retired electronic engineer who has dedicated his life to researching health effects of EMF exposures and raising public awareness about this serious health issue. In their study, Milham and Morgan studied a cancer cluster at La Quinta Middle School in California. The school first opened in 1988 and was incorporated into a new building in 1990. By 2005, 16 staff among the 137 who had ever worked at the school had been diagnosed with 18 cancers, a rate nearly 3 times higher than expected. The cancers included melanoma, thyroid, uterine, breast, colon, pancreatic, ovarian, larynx, lymphoma, and multiple myeloma. In addition, about a dozen cancers have been detected among former students of the school.

In analyzing the environment of the school, Milham and Morgan discovered that dirty electricity levels in the building were very high. Through careful analysis of teacher data, as well as data on levels of dirty electricity in classrooms and on cancer rates in the general population, they determined there was a positive correlation between dirty electricity and the incidence of cancer at La Quinta Middle School. More specifically, they determined that 64 % of the cancers at the school could be attributed to dirty electricity – a very high proportion for any occupational study. Interestingly, they discovered that the 60 Hz magnetic fields present at the school showed NO association with cancer incidence. It was the dirty electricity present in the building that was potentially the problem.

While research in this area needs to be expanded, findings like these suggest that reducing dirty electricity in places where people spend time (e.g., home, school, work) may be one important strategy for lowering cancer risk. The same is likely true for other forms of EMF pollutions.

Diabetes and Dirty Electricity

Cases of diabetes have increased significantly since the 1980's. Until recently, this increase was attributed almost exclusively to poor dietary habits, limited physical exercise, and obesity. Now there is evidence that exposure to dirty electricity may also be linked to diabetes. Research has shown that high levels of dirty electricity can elevate blood sugar.

In one study, Lloyd Morgan showed the blood sugar levels of one non-diabetic rise to diabetic levels in environments where dirty electricity was high. In another study, Dr. Magda Havas, a researcher and professor at Trent University in Canada, found that plasma glucose levels of two Type 1 diabetics and two Type 2 diabetics responded directly to the amount of dirty electricity in their environment. The Type 1 diabetics required less insulin in environments with low levels of dirty electricity. Blood sugar levels of the Type 2 diabetics increased with higher levels of dirty electricity.

Dr. Havas has also analyzed blood sugar data for diabetics in a Canadian long-term care facility and a Japanese clinic in which plug-in dirty electricity filters were installed in outlets to reduce dirty electricity levels. Of the five diabetics in the long-term care facility (for whom data were available), two (both Type 1 diabetics) had significantly lower fasting plasma glucose levels after the filters were installed. In the Japanese clinic, the plasma of the three diabetics studied became less viscous and their blood sugar dropped within 30 minutes after dirty electricity was reduced in the building from a very high level. Based on her findings, Dr. Havas distinguished between true Type 1 and Type 2 diabetics and a third type of diabetes that she calls Type 3 diabetes. The blood sugar and blood viscosity of Type 3 diabetics are affected by dirty electricity in their environment, while this does not appear to be the case for true Type 1 and Type 2 diabetics.

These findings suggest that some diabetics and pre-diabetics may benefit greatly from reducing dirty electricity in their homes and other places where they spend significant time. Doing so may help them better regulate their blood sugar levels.

Asthma and Dirty Electricity

Like diabetes, there has been a rise in the incidence of asthma in recent years. There is some evidence to suggest that exposure to dirty electricity, which has also increased dramatically since the 1980s, may be one contributing factor in its growth.

Researchers believe the correlation between dirty electricity and asthma may be akin to an allergic reaction. Noted researcher Dr. Olle Johansson suggests that electrical fields, such as those created by dirty electricity, trigger our immune system to release inflammatory substances such as histamines and cytokines as a protective mechanism. These markers of inflammation have been shown to highly correlate with asthma and other allergic reactions.

Reducing exposure to dirty electricity may help alleviate asthma symptoms, especially for individuals who are particularly sensitive to this form of EMF pollution. One research study conducted by Dr. Magda Havas in a Wisconsin elementary school showed that asthma symptoms nearly disappeared when high levels of dirty electricity were reduced in classrooms. Of the 37 students at the school who required asthma inhalers at the start of the study, only three continued to need them at school after dirty electricity levels were reduced.

Behavior/Learning and Dirty Electricity

Schools are full of devices that generate dirty electricity, including fluorescent lights and electronic equipment such as computers, printers, digital projectors, copy machines, and more. Nearby power transmission lines and cell towers may also contribute to high levels of dirty electricity in schools. Research suggests that dirty electricity may interfere with student learning as well as teacher health and wellbeing. Dr. Magda Havas has studied the effects of dirty electricity in schools in Ontario, Canada as well as Wisconsin and Minnesota in the United States. She found that reducing levels of dirty electricity at the schools led to better student behavior (as reported by teachers). More specifically, students participated more actively in class, were more focused and responsive, and had fewer health complaints. Teachers had to spend less time dealing with disruptions, repeating instructions, and starting new lessons. In addition, many teachers reported feeling less frustrated, tired, and irritable. They were better able to focus and concentrate on their teaching and reported better mood (e.g., less anxiety and depression) and better health (e.g., less headaches, dizziness, body pain, fatigue/weakness, asthma symptoms, skin irritations).

Based on these findings, reducing dirty electricity in schools may create classroom environments that are more conducive to productive learning, especially for students and teachers who may be particularly sensitive to this form of EMF pollution.

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MEASURING DIRTY ELECTRICITY

There are ways to measure dirty electricity levels in your home and other places where you spend time. Taking measurements can help you determine whether levels are higher than desirable for health. It can also assist you in identifying key sources of dirty electricity in your environment. This and other information gathered during the measurement process is valuable as you explore and select options for reducing this type of EMF pollution around you. Measurements are also important for determining whether your efforts to reduce dirty electricity are successful.

In this section, we'll cover some common approaches and tools for measuring dirty electricity and a general protocol for taking measurements.

Measurement Approaches and Tools

There are two MAIN approaches for measuring dirty electricity.

1. Measuring the dirty electricity flowing along the electrical wiring in circuits.
2. Measuring dirty electricity fields in the air (i.e., radiated dirty electricity).

APPROACH 1

Measuring Dirty Electricity Flowing Along Electrical Wiring

This is probably the most common way of measuring this type of EMF pollution. The dirty electricity flowing along wiring in circuits is the primary source of dirty electricity fields (i.e., AC electric and magnetic fields greater than 50/60 Hz) that radiate into rooms. For this reason, it's good to measure the dirty electricity on your wiring directly.

The two MAIN ways to measure the dirty electricity flowing along building wires are with an oscilloscope (and related equipment) or a plug-in EMI meter.

Oscilloscope

The best way to get comprehensive and detailed information about the dirty electricity present on building wires (e.g., strength, frequency, etc.) is to use an oscilloscope. Oscilloscopes can measure dirty electricity riding on top of both the VOLTAGE and CURRENT waveforms of conventional 50/60 Hz electricity. They are able to detect a broad range of dirty electricity frequencies, including a majority of those commonly found on electrical wiring today. Unfortunately, oscilloscopes are complicated to use, typically requiring significant expertise and experience to operate and interpret properly. They can also be expensive and often require peripheral parts or other equipment to function most effectively. Not everyone will be able to invest time in learning to use this instrument.

Plug-In EMI Meter

An easier way for most people to measure the dirty electricity riding building wires is with a plug-in EMI (electromagnetic interference) meter, also known as a line noise meter or microsurge meter. These meters are easy to use. Simply plug the meter's cord into electrical outlets to measure the level of dirty electricity flowing along nearby wiring.

Plug-in EMI meters measure dirty electricity frequencies riding on top of the VOLTAGE waveform of conventional 50/60 Hz electricity. The frequency range covered by these meters varies by manufacturer. It is not as broad as the frequency range of oscilloscopes, but typically covers an important band of traditional dirty electricity noise found on electrical wiring. When choosing a plug-in EMI meter, it's generally advisable to select a model that can detect dirty electricity frequencies from around 5 kilohertz (or lower) to 1 megahertz (MHz). This will help ensure that you are able to detect most common dirty electricity frequencies.

Different plug-in EMI meters use different measurement units, such as millivolts or GS units, to report dirty electricity readings. The manufacturers of plug-in meters typically provide a target dirty electricity level. You can compare your readings to the recommended target to gauge whether dirty electricity levels in your environment may be higher than desirable.

The [Greenwave Broadband EMI Meter](#) shown to the right is an example of a plug-in dirty electricity meter. This and other plug-in meters can be used for a variety of purposes, including the following:

- Measuring the level of dirty electricity flowing along the electrical wiring in homes and other buildings.
- Estimating how much dirty electricity is entering a building from EXTERNAL (outside) sources via power supply lines, etc.
- Identifying sources of dirty electricity INSIDE a home or other building.
- Gauging the effectiveness of dirty electricity filters and other dirty electricity mitigation strategies.
- Guiding the installation of dirty electricity filters for optimal results.



More information about how to use a plug-in EMI meter to take dirty electricity measurements will be provided later in this section. Dirty electricity filters will be discussed in the final section of this guide.

APPROACH 2

Measuring Dirty Electricity Fields in the Air (a.k.a. Radiated Dirty Electricity)

This approach involves measuring dirty electricity fields that have radiated into rooms from electrical wiring, power cords, and AC powered devices. Generally speaking, dirty electricity fields include AC electric and magnetic fields higher than 50/60 Hz in frequency. (NOTE: Electric fields from dirty electricity are more common in properly wired rooms than magnetic fields from this type of EMF pollution. These electric fields can extend approximately 4 – 8 feet from electrical wiring and power cords. They don't tend to extend as far from the devices that actually create dirty electricity.)

Two tools that can be used to measure or detect radiated dirty electricity are an oscilloscope and AM radio.

Oscilloscope

An oscilloscope equipped with a special antenna can be used to measure dirty electricity fields that have radiated into rooms from electrical wiring, power cords, and AC powered devices. Oscilloscopes can provide detailed information about radiated dirty electricity, but as explained earlier, are complicated to use and typically require expertise and experience to operate effectively.

Portable AM Radio

One simple and inexpensive tool for detecting radiated dirty electricity in the air and for helping identify sources in your environment is a small, battery-operated AM radio (without noise suppression technology). To test for dirty electricity, tune the radio to a spot near the low end of the AM dial where you hear only static (i.e., white noise) rather than a radio station. (Tuning the radio to a similar spot on the FM dial will NOT work.)

- Walk around with the radio, turning it in various directions and holding it near electric and electronic items that are turned ON and operating (e.g., light dimmer switches, lamps with energy-efficient light bulbs, computers, printers, charging devices, gaming systems, electric appliances, etc.).

The static on the radio will sound noticeably louder and/or more “crackly” when dirty electricity is present. Sometimes sources of dirty electricity may even cause the radio to make other types of noises such as pronounced clicking or high-pitched whining/squeaking sounds.

- If you suspect a device is generating dirty electricity, turn the device OFF and then back ON, noting changes in the loudness or nature of the static on the radio.

For example, the sound of static on the radio may be normal when a light dimmer switch is turned OFF. When the dimmer switch is turned ON and adjusted to different levels of light, the static on the radio will usually get noticeably louder and may change in other ways too.

- When you identify an electric or electronic device that's producing dirty electricity, you can use the AM radio to estimate how far the related dirty electricity field extends from the device. Hold the radio close to the device, then slowly move it farther and farther away. Note how far (in inches or feet) the radio is from the device when the static begins to sound more “normal” again. This will tell you approximately how far the dirty electricity field extends.

While an AM radio can be useful for detecting the presence of radiated dirty electricity in rooms and for identifying possible sources, it cannot “quantify” the levels (strength) of dirty electricity in your environment. In other words, it cannot produce specific measurements that can be compared to recommended target levels.

SPECIAL NOTE about Attempting to Use AC Electric Field Meters, AC Magnetic Field Meters (Gaussmeters), and Radio Frequency (RF) Meters to Measure Radiated Dirty Electricity

Many people try to use AC electric field meters, body voltage meters, AC magnetic field meters (gaussmeters), and radio frequency (RF) meters to measure RADIATED dirty electricity. With some exceptions, these types of meters are generally NOT suitable for measuring dirty electricity in useful ways for a variety of reasons. This is especially true of inexpensive, consumer-level models. For more information about WHY, see *Appendix B* at the end of this guide.

Summary

At this time, the easiest and most economical way to measure specific levels of dirty electricity in homes and other settings is with a plug-in EMI meter. A portable AM radio can also be helpful as a companion tool for identifying sources of dirty electricity in your environment.

General Measurement Protocol

There are different ways to go about taking dirty electricity measurements in a building. The general protocol described below outlines one method for measuring dirty electricity in homes using a plug-in EMI meter. It involves the following three steps. Each step will be described in more detail below.

1. Measuring dirty electricity from EXTERNAL (outside) sources.
2. Taking baseline dirty electricity measurements inside your home.
3. Identifying INTERNAL (inside) sources of dirty electricity.

Step 1

Measure Dirty Electricity from EXTERNAL (Outside) Sources.

This measurement step will help you estimate the amount of dirty electricity entering your home from EXTERNAL sources. As a reminder, dirty electricity from EXTERNAL sources is generated in other homes and buildings and by infrastructure, such as cell towers, that run on electricity. It can find its way “onto” your electrical wiring (circuits) and other “unwanted places” via power supply lines and other means. Estimating the amount of dirty electricity coming from EXTERNAL sources can help you determine how important it might be to filter dirty electricity at your main electrical panel. (Information about dirty electricity filters will be provided in the final section of this guide.)

General Process

- Turn OFF all circuits in your main electrical panel except for ONE circuit.

We'll refer to the circuit left ON as the "test" circuit.

It's a good idea to choose a "test" circuit that does not have many "loads" running on it. By "loads" we mean any equipment, appliances, or other devices that run on electricity. *(Choosing a low-load "test" circuit will make the next step in this process easier.)*



- Make sure there are NO internal loads running on the "test" circuit.

In other words, turn OFF and unplug all equipment, appliances, and other devices normally used on the "test" circuit.

By turning OFF all other circuits and turning OFF and unplugging all loads on the "test" circuit, you will temporarily eliminate all INTERNAL sources of dirty electricity.

- Using a plug-in EMI meter, measure the dirty electricity present on the "test" circuit.

Do this by plugging the meter into an electrical outlet that is part of the circuit. (It's optimal to take this measurement in an outlet as close to the main electrical panel as possible.)

Because you've temporarily eliminated internal sources of dirty electricity from the "test" circuit, the measurement you take should reflect dirty electricity from external sources that is entering your electrical system via power lines (and possibly other means).

- Make note of the EXTERNAL dirty electricity reading for future reference.
- It's best to repeat the steps above with a second "test" circuit. When choosing the second "test" circuit, select one that is supplied by the opposite electricity supply line (leg) as the first.

In North America, your main electrical panel is fed by two 120V supply lines. Let's call these supply line (or leg) A and supply line (or leg) B. Each of the 120V circuits in your main electrical panel is supplied with electricity by either supply line (leg) A or supply line (leg) B. If your original "test" circuit was supplied by supply line (leg) A, make sure your second "test" circuit is supplied by supply line (leg) B.

- Finally, consider taking several sets of EXTERNAL dirty electricity measurements, for example readings during the day and in the evening.

The level of dirty electricity flowing along power lines and building wires is directly affected by the number and types of electrical loads operating at any given moment. It can vary at different times of the day, different days of the week, and even in different seasons. For example, dirty electricity levels in homes and neighborhoods can be higher in the evenings when people return home from activities (e.g., school, work) and turn on appliances, TVs, gaming systems, computers, air filters, etc. For this reason, it can be helpful to take more than one set of readings if time permits. If time is sparse, try to take your measurements at a “high impact” time such as a weekday evening.

Step 2

Take Baseline Dirty Electricity Measurements Inside Your Home.

This measurement step involves taking dirty electricity readings in rooms throughout your home with internal “loads” turned ON. The process can help you get a sense of the overall dirty electricity “landscape” in your environment. You’ll be able to see whether levels are higher than desirable and whether they are stronger in some rooms or areas than others. The information you gather can provide insight about where to begin your search for dirty electricity sources (Step 3), and later, where to focus at least some of your initial mitigation (reduction) efforts. The readings will provide a valuable baseline for “BEFORE mitigation” and “AFTER mitigation” comparisons.

General Process

- **Turn ON lights and other electric and electronic equipment, appliances, and devices (i.e., loads) typically used in your home, such as computers, printers, TVs, video game systems, device chargers, air filters, fans, heating and cooling systems, pool pumps, well pumps, etc.**

Refer back to the list of common dirty electricity sources earlier in this guide for more ideas of items to turn ON. Remember, it’s these types of items that generate dirty electricity. It’s important to have them ON and running when taking measurements so that your readings are likely to reflect typical levels of dirty electricity in your environment. (For items such as furnaces, air conditioners, pool pumps, well pumps, and other items that “kick on” intermittently, make sure to adjust temperature or other settings so that the items are actively running while you take readings.

- **Take dirty electricity readings in outlets throughout your home, one room at a time. Record the readings on a piece of paper for future reference, making special note of rooms or areas with particularly high readings.**

It can be helpful to draw a simple map of each room that includes the location of accessible electrical outlets and the dirty electricity reading recorded for each. It’s also helpful to include notes about the different electric and electronic equipment, appliances, and other devices plugged into various outlets in the rooms.

STEP 3

Identify INTERNAL sources of dirty electricity.

This step involves identifying specific equipment, appliances, and other devices in your home that are contributing internally to the dirty electricity flowing along your wiring. It can be carried out in tandem with Step 2 above or afterwards, whichever works best for you. The information gathered can be very valuable as you plan and implement specific strategies and actions for reducing dirty electricity in your environment. ***It can be helpful to use both a plug-in EMI meter and a portable AM radio to carry out this step.***



General Process

The process described below may seem a little complicated and laborious. You can decide how deep to go with it. The overall goal is to identify the worst dirty electricity “offenders” in your environment so that you can decide whether and how to mitigate the electrical noise they create.

- Start in the room with the highest dirty electricity readings from STEP 2.
- Optional (but helpful):
Use a small, battery-operated AM radio to get a quick sense of items in the room that may be generating dirty electricity. (Basic instructions for using an AM radio to detect the presence of dirty electricity and identify sources can be found on page 14 of this guide.)
- Plug an EMI meter into an electrical outlet in the room. (It’s generally best to choose the outlet with the highest dirty electricity reading.)
- Turn OFF and unplug “loads” in the room one at a time, noting the effect that doing so has on dirty electricity readings. (As a reminder, a “load” is any equipment, appliance, or other device that runs on electricity.)

- If your dirty electricity reading DECREASES after turning off and unplugging a load, the load is an internal source of dirty electricity in your environment. The greater the decrease in the reading, the more that particular load is contributing to the dirty electricity present on your wiring.
- Take notes about which items in the room create dirty electricity. For each item, it can be helpful to include information about how much dirty electricity it creates. For example, jot down the dirty electricity reading before an item is turned OFF and unplugged and after, and note the difference.
- When you are done in the first room, move to the room with the next highest readings from STEP 2 and repeat the process above.
- Continue moving from room to room until you've identified all the significant sources of dirty electricity in your environment.

SPECIAL TROUBLESHOOTING NOTE

If dirty electricity readings in a room are particularly high and turning off all the loads in the room doesn't make much difference in the readings, you may need to investigate further to figure out what loads in other rooms and/or on different circuits may be contributing to the high dirty electricity level in the room you're testing. Here is one idea for how to do this:

- Turn OFF circuit breakers in your main electrical panel (and subpanels if you have them) one at a time to see what affect that has on dirty electricity readings in the room you're testing.

(IMPORTANT: Do NOT turn off the circuit breaker that controls the electrical outlets in the room you're testing. For testing purposes, it's important for that circuit to be left ON.)

A small, battery-operated AM radio can be helpful in this process too. (Refer back to the basic instructions earlier in this guide for how to use a small, battery-operated AM radio to detect dirty electricity and identify sources.) Here are the basics: Tune the radio to a spot near the low end of the AM dial where you hear only static (i.e., white noise) rather than a radio station. Hold the radio near the circuit breaker panel as you are turning circuit breakers OFF. If the dirty electricity noise detected by the radio decreases significantly when you turn a particular circuit breaker OFF, that may be a "problem" circuit that needs to be further investigated. See below for what to do next.

- If you discover one or more circuits that are having a large effect on dirty electricity readings in the room you're testing, you can then turn the loads that are running on those circuits OFF one at a time to see which is/are causing the high dirty electricity levels in the room you're testing. If a "problem" circuit only has one load running on it (*for example*: a furnace, AC unit, pool pump, or electric vehicle charging station), then you'll know right away what the problematic equipment, appliance, or device is.

Protecting Yourself Against Dirty Electricity

Dirty electricity is becoming more prevalent in homes and other buildings. The good news is there are things you can do to protect yourself and loved ones against this fast-growing form of EMF pollution and its potential health effects.

Basic Protection Protocol

We believe the BEST dirty electricity protection plan includes THREE general steps. We refer to these as the **THREE M's**.

1. Measure
2. Mitigate
3. Measure Again.

Step 1: MEASURE

Start the process by taking EMI measurements so that you understand the dirty electricity “landscape” in your home. Ideally, this step will involve the following:

- Estimating the amount of dirty electricity entering your home from EXTERNAL (outside) sources via utility supply lines and other means.
- Taking dirty electricity readings throughout your home to obtain baseline readings and identify rooms or areas where readings are the highest.
- Identifying specific sources of dirty electricity INSIDE your home.

For this step, we recommend using a plug-in EMI meter (such as [Greenwave's Broadband EMI Meter](#)) for taking dirty electricity measurements. A small, battery-operated AM radio (without noise suppression technology) can be a great companion tool for helping identify sources of dirty electricity in your environment. *(Refer back to the last section of this guide for more details about taking dirty electricity measurements.)*

The information you gather here will set the stage for Step 2 in the protection process (i.e., mitigation), providing important details and insights to help inform your selection of strategies and actions for reducing dirty electricity.

Step 2: MITIGATE

This step involves taking specific actions to reduce dirty electricity in your environment. It's generally best to focus first on rooms or areas of your home where you spend the most time and where dirty electricity readings are highest. Addressing dirty electricity sources you use frequently and for extended periods of time is also important. *(Examples of specific actions you can take to reduce dirty electricity are described later in this section.)*

Step 3: MEASURE AGAIN

After doing things to reduce dirty electricity in your environment, it's important to take measurements again to ensure your efforts are having the intended effect. In fact, it's a good idea to take measurements throughout the mitigation process to ensure that each action you take helps.

Overarching Strategies for Reducing (Mitigating) Dirty Electricity

There are a variety of specific actions you can take to reduce dirty electricity levels in your environment. Before getting into specifics, let's take a quick look at a few key overarching strategies. Some combination of these strategies is usually required to mitigate dirty electricity most effectively in homes and other buildings.

- **Eliminate or reduce sources of dirty electricity in your environment.**

This is the BEST first step in mitigating dirty electricity and is why we recommend identifying sources as a key step in measuring dirty electricity.

- If you do NOT use a particular source of dirty electricity very often and don't really need it, then consider getting rid of it entirely.
- For sources you do use and need, see if they can be replaced with alternatives that produce less or no dirty electricity. This is especially important in your sleeping area and other locations where you sit, stand, or lie down for extended periods of time.

The logic here is obvious. The less sources of dirty electricity you have in your home, the less dirty electricity you'll have flowing along electrical wiring and power cords, and the less high frequency dirty electricity fields you'll have radiating into rooms where you and others spend time.

(For a reminder of common dirty electricity sources in homes and other settings, refer back to the list provided on page 7 of this guide.)

- **Limit or reduce time spent using dirty electricity sources.**

This strategy pretty much speaks for itself. The less you use dirty electricity sources and the less they are turned ON and running, the less dirty electricity they will contribute to your environment and the lower your exposures will be.

Among other things, this can provide wonderful opportunities to “unplug” and enjoy more time taking walks, exploring nature, reading books, socializing with friends, meditating, etc.



- **Create distance between yourself and dirty electricity sources.**

Generally speaking, the closer you are to a source of dirty electricity (or any type of EMF pollution), the higher your exposure level will be. As you move away from the source, the strength of exposure decreases. So, distance is your friend when it comes to dirty electricity and other EMF pollution exposures!

Whenever possible, try to create distance (at least 4 – 6 feet) between yourself and known sources of dirty electricity such as power cords, electrical wiring (behind walls, above ceilings, under floors), etc. This is especially important in locations where you sit, stand, or lie down for extended periods of time.

- **Fix wiring errors and eliminate electrical current on metal water pipes, gas pipes, cable TV lines, etc.**

These types of problems cause elevated AC magnetic fields in homes, typically at unhealthy levels.

If there is dirty electricity flowing through circuits affected by wiring errors, the elevated magnetic fields that radiate from electrical wiring will include “dirty” high frequency AC fields as well as the 50/60 Hz magnetic field from conventional electricity. Both are unhealthy! The same will be true if there is dirty electricity present in current flowing along metal water pipes, gas pipes, cable lines, telephone lines, or other “unwanted” places.

If these types of problems exist in a home (or other building), they should be traced and fixed, especially if they affect high-use areas. This will usually require the help of an experienced EMF professional working in tandem with a licensed electrician and/or plumber.

(Appendix C at the end of this guide provides some basic information about why wiring errors and current flowing on inappropriate surfaces cause elevated AC magnetic fields. These issues are also discussed briefly in the “Dirty Electricity Filters” section of the guide.)

- **Consider shielding electric fields in your environment.**

There are shielding materials that can protect you from the AC electric fields radiating off power lines, circuit wiring, power cords, and more. They work for both 50/60 Hz electric fields from conventional electricity and higher frequency electric fields associated with dirty power. Some can also work for radio frequency (RF) radiation from wireless devices and technology. (Most affordable options do not work for AC magnetic fields.)

Shielding can be as simple as replacing unshielded power cords with shielded alternatives or as complex as installing shielded wiring throughout a building or protecting a room or whole home with special paint and window coverings. If you are serious about considering shielding options (especially complicated, large-scale projects), we strongly recommend working with a highly experienced EMF professional. Why? Because if shielding is not done properly or if homeowners are not aware of important caveats associated with shielding, EMF exposures can become worse rather than better.

- **Install dirty electricity filters.**

These days, it can be hard to get rid of ALL dirty electricity sources or replace them with “clean” alternatives. Even if we could, it’s still common for some or a lot of dirty electricity from EXTERNAL (outside) sources to find its way onto a home’s wiring via utility supply lines and other means. This is where dirty electricity filters come in handy. These filters help mitigate the dirty electricity flowing along building wires. The less unmitigated dirty electricity there is flowing along circuit wiring (especially for long spans), the less that will radiate into your environment.

Dirty electricity filters (and associated considerations) are discussed in the final section of this guide.



Greenwave Filter

Specific Actions for Reducing Dirty Electricity

EXAMPLES

At first glance, the task of tackling dirty electricity in your home or other places might seem a bit overwhelming. For this reason, it’s a good idea to prioritize. We recommend starting with actions that seem manageable and that will affect areas where you spend the most time (e.g., your bedroom, other areas where you relax and unwind, and your work space at home or elsewhere). It’s also important to address sources of dirty electricity that you use frequently and for extended periods of time.

As you plan specific actions for reducing dirty electricity in your environment, consider these questions:

1. What actions can I take now?
2. What actions do I want to take later when time and resources allow?

The list of actions that follows is far from exhaustive, but provides some examples of specific things (both small and large) that can be done to reduce dirty electricity in homes and other buildings. As you’ll probably notice, these actions usually relate to one or more of the overarching strategies described previously. Clearly, some are easier and less expensive to take than others. And, taking certain actions such as installing shielded electrical wiring throughout your home, make it less important or unnecessary to take others (e.g., turning off electrical circuits at night). One relatively common action – **installing dirty electricity filters** – will be discussed separately, in the final section of this guide.

- **Replace compact fluorescent light bulbs, fluorescent tubes, low voltage halogen bulbs, and “dirty” LEDs with incandescent bulbs or “clean” LED options.** Any light bulb that runs at line voltage or has built-in filtration should not produce dirty electricity. (Line voltage is 120 Volts in some parts of the world and 220-240 Volts in others.)

You can test your light bulbs or those you are considering as replacements to see if they generate dirty electricity and how much. Check out this blog article – [Do My Light Bulbs Produce Dirty Electricity?](#) – for tips on how to do this using a plug-in dirty electricity meter, such as Greenwave’s Broadband EMI Meter.

(CAUTION: Make sure to dispose of compact fluorescent bulbs and fluorescent tubes properly as they contain mercury and can be hazardous to you and the environment if they break.)

- **Replace light dimmer switches with regular ON/OFF switches.**

If there is an area of your home where you’d like the option of different levels of light at different times, consider installing multiple sets of lights to serve the area. You can adjust the light level by turning all or only some of the lights on. Similarly, you can outfit the different sets of lights with different watt bulbs and choose which set or sets of lights to turn on accordingly. (In either case, make sure to use light bulbs that do not produce dirty electricity.)

If you opt to keep your dimmer switches (at least temporarily), turn them OFF when you are not using them. When they are ON, it’s generally best to use them either on the lowest or highest setting rather than settings in between.

- **Reconfigure the wiring for LED light strips under counters and cabinets.**

In a “Microsurge Electrical Pollution” course created for the Building Biology Institute, EMR specialist Mitch Marchand offers an interesting idea for reducing dirty electricity associated with under-cabinet (and counter) LED light strips. He suggests moving the LED driver for an LED light strip to a home’s main electrical panel and then running a direct current (DC) line from the driver to the light strip. He then advises filtering dirty electricity on the relevant circuit right at the main electrical panel.

- **Turn OFF and UNPLUG AC powered electronics and other electric devices when you are not using them.**

When turned OFF and unplugged, AC powered equipment, appliances, and other devices will NOT generate dirty electricity and “feed it” back to the wiring in electrical circuits where it can then spread and radiate. This will help save electricity too!

You may be wondering... Do I really need to UNPLUG devices in addition to turning them OFF? There are two reasons why unplugging power cords is important, especially near spots where you spend a lot of time (e.g., bed, desk, etc.).

FIRST, many devices, especially certain electronics, are not completely OFF when you turn them OFF. For example, some items like TVs and computers go into a special “stand-by” mode when “OFF.” In this mode, they draw some power and do a bit of work “behind the scenes.” They can still be generating dirty electricity at these times.

SECOND, most standard power cords are unshielded. Electric fields radiate into rooms from unshielded power cords that are plugged into outlets, even when the devices attached to the cords are turned OFF. This is true for both the 50/60 Hz electric fields from conventional electricity and the higher frequency electric fields associated with dirty electricity. You eliminate this problem when you unplug cords from outlets.

We realize that unplugging and re-plugging cords can be inconvenient, especially when electrical outlets are behind furniture or in other hard-to-access areas. Here are a few ideas for dealing with this:

- Replace unshielded lamp and device cords with shielded alternatives. Electric fields will not radiate into rooms from shielded power cords. This is true when devices powered by these cords are ON as well as OFF.
- Plug multiple items into a single power strip and then unplug the power strip after turning the items OFF. Unplugging one cord is easier than unplugging several.
- Better yet, plug multiple devices into a **shielded** power strip with an ON/OFF switch. Rather than unplugging the power strip, you can simply turn the switch on the strip OFF. This will cut OFF power to the strip and all the cords plugged into it. (This strategy is only effective if you use a power strip with a shielded cord.)
- Another option is to plug devices into special power switch adapters rather than directly into outlets. These adapters (see examples below) plug into electrical outlets and have one or more built-in sockets that you can plug devices into. They are also equipped with an ON/OFF switch or come with a small remote-control device. Turning the power switch adapter OFF with the manual switch or remote-control device will cut power to the entire cord as well as the device attached to it. No power (voltage) to the cord means no electric fields from “conventional” or “dirty” electricity radiating off it.



- **Use your laptop in battery mode whenever possible and never use it directly on your lap.**

It's far better to place the laptop on a hard surface (preferably NOT metal) to create distance between yourself and the device.

If you have to use your laptop while it's plugged into an AC power source (outlet), take steps to "ground" it. You can find ideas for how to do this in the article **Safer Use of Computers** by building biologist Oram Miller of Create Healthy Homes. We also recommend using a wired (not wireless) external keyboard and mouse rather than the built-in keyboard and trackpad (touchpad) on your laptop, especially when you will be using your laptop for long periods of time.

It's also a good idea to use a wired (rather than wireless) internet connection and to turn OFF the Wi-Fi and Bluetooth functionality on your laptop. This will help protect you against radio frequency (RF) radiation, another type of EMF pollution.

- **Avoid metal bed frames, desks, chairs, etc.**

Metal is conductive and can provide a handy pathway for electric fields (from both "conventional" and "dirty" electricity) to travel from building wires, power cords, and AC powered devices onto your body. It's best to replace metal furniture and lamps (especially those you use a lot and for long periods of time) with options made of wood or other non-conductive materials. If you can't replace these items right away, take steps to "ground" them. This will provide a more convenient path for electric fields to take.

- **Whenever possible, position furniture you use a lot as far from walls as you can.**

Remember, distance is your friend when it comes to radiated dirty electricity and other forms of EMF pollution. The farther you are from walls, the weaker the dirty electricity fields radiating from wiring will be.



Too Close to Walls



BETTER

- Don't run unshielded extension cords or other AC power cords (that are plugged into outlets) under your bed, couch, favorite reading chair, etc.

Similarly, keep unshielded power cords under your desk tucked as far as possible from your feet and legs.

- **BEST dirty electricity solution for sleeping areas:**

Quality sleep is essential for good health. For this reason, it's especially important to reduce dirty electricity and other EMF exposures in your bedroom.

Before going to bed, consider turning OFF electrical circuits that affect your sleeping area. With these circuits OFF, minimal or no ELECTRIC fields from "conventional" or "dirty" electricity will radiate from circuit wiring (hot wires) or power cords into your bedroom.

The circuits that affect your sleeping area will typically include circuits for outlets and overhead light fixtures in your bedroom, but can also include circuits for rooms next to, above, and/or below your bedroom. There is a process you can go through on your own or with the help of an EMF professional to determine which circuits to turn OFF. Circuits can be turned OFF manually at your breaker panel (by flipping breakers off) or via special "cut-off" switches installed by an electrician.

NOTE:

If you have shielded wiring throughout your home, you do NOT need to turn circuits off at night. However, you will need to unplug power cords from outlets (unless the cords are shielded too).

- **OTHER dirty electricity solutions for sleeping areas:**

If you DON'T want to turn electrical circuits OFF at night, here are examples of other actions you can take to help reduce dirty electricity levels while you're sleeping:

- Remove all AC powered electric and electronic devices from your nightstand.
- Turn OFF and unplug all other AC powered appliances and devices in your bedroom before going to sleep.
- Use a battery-operated alarm clock and lamp on your nightstand rather than similar items powered by electricity.
- If you opt to use an electric lamp on your bedside table, plug it in via a power switch adapter like those described previously. Turn the lamp ON and OFF manually or remotely using the power switch adapter rather than the switch on the lamp. Turning the lamp OFF this way will cut power to both the cord and the light bulb.

- Do NOT charge your cell phone on your nightstand. If you use your phone as an alarm clock, charge it prior to going to bed and then unplug it and put it in airplane mode. (If you need to charge your phone overnight, do so using a battery power bank with your phone in airplane mode.)
- Use a regular blanket or comforter (e.g., wool, down) rather than an electric blanket on your bed.
- If you have an electric bed, adjust it to the level you want and then turn the bed OFF and unplug it. If unplugging the bed is inconvenient, plug its cord into the type of power switch adapter described earlier. Turn power to the bed OFF and then turn power to its cord OFF manually or remotely using the power switch adapter.
- If you have a metal bed frame or a mattress with metal box springs, consider replacing them with alternatives made of non-conductive materials. If replacing them is not an option, take steps to "ground" them.
- Shield all or part of your bedroom (with shielding paint or other appropriate materials) to prevent AC electric fields from "conventional" and "dirty" electricity from radiating into the room from circuit wiring behind walls, above ceilings, and under floors. This can be particularly helpful behind the head of your bed and under the bed too if your bedroom is on the second floor with another room beneath it. (As mentioned previously, we strongly recommend working with an experienced EMF professional if you are considering shielding projects to ensure that the shielding helps not hurts.)
- If you have a smart (wireless) or PLC (power line communication) utility meter, contact your utility company to see if you can have it replaced with an analog meter that does NOT communicate usage data wirelessly or via power lines.



Analog Utility Meter



Smart Utility Meter

- **Replace plastic-coated Romex electrical wiring with a shielded alternative (e.g., metal-clad wiring or Romex wiring run through metal conduit).**

The electrical wiring in most homes is plastic-coated Romex, which is NOT shielded. As a result, AC electric fields from both “conventional” and “dirty” electricity will radiate off the wiring into rooms all of the time unless circuit breakers are turned OFF or there is a power outage. Replacing Romex wiring with a shielded alternative will prevent electric fields from radiating into rooms. Generally speaking, this is easier to accomplish if you are building a new home or renovating your existing home. A shielded wiring installation will be more expensive than plastic-coated Romex wiring, but can be well worth it from a health perspective.

- **When choosing a new furnace, AC unit, pool pump, well pump, and other similar equipment, AVOID models with variable speed motors/drives if possible.**

It may make sense to consult with an EMF professional to see if they can recommend particular brands and models that may be suitable.

- **Before installing a solar power system for your home, consult with an experienced EMF specialist regarding the potential EMF implications.**

The inverters used to convert the low voltage DC electricity (direct current) produced by solar panels into the higher voltage AC electricity (alternating current) required in homes and other buildings can generate significant amounts of dirty electricity. Many solar power systems are also a source of wireless (radio frequency) radiation, another form of EMF pollution. An EMF professional can help you identify solar power systems and set ups that minimize dirty electricity and RF radiation.

Individuals who are electromagnetically hypersensitive may want to avoid installing solar panel systems altogether.

- **When building a new home or planning a major renovation, try to position large dirty electricity sources as close to your main electrical panel as possible and far from areas where people will spend a lot of time.**

Examples of large dirty electricity sources include HVAC equipment (e.g., furnace, AC unit), smart appliances, electric vehicle charging stations, solar inverters, well pumps, and pool pumps among other things. The overall goal is to minimize the wiring distance between your main electrical panel and large dirty electricity sources, and to maximize the distance between these sources and areas of the home where you and others will spend a lot of time (e.g., bedrooms, family room, home office).

Dirty Electricity Filters

When it comes to reducing dirty electricity in your environment, it's always best to eliminate or replace sources FIRST (to the extent possible). In reality, this can be challenging. So many common items we use in our homes and other places these days generate dirty electricity. Trying to eliminate or replace them all can be difficult and expensive, and is not always feasible. In addition, even if you are able to "clean up" all or most dirty electricity sources in your own environment, you can still have some or a lot of electrical noise riding into your home from your neighbors and other external sources.

This is where dirty electricity filters come in handy as a supplement to your other reduction efforts. These filters target the dirty electricity flowing along electrical wiring throughout your home. They can be used to address EXTERNAL dirty electricity entering your home via power supply lines and other means. They can also be used to filter dirty electricity generated by equipment, appliances, and other devices INSIDE your home. The general idea is simple: the less unmitigated dirty electricity you have flowing along building wires, the less that will radiate into your environment.

General Filter TYPES

There are TWO general types of dirty electricity filters.

1. CAPACITIVE Filters

Capacitive filters are installed "in parallel" to your electrical system and work by shorting out high frequency VOLTAGES. As these frequencies pass through a filter, they are shorted, which creates a bit of "dirty" current. This current is shunted primarily to the circuit's neutral wire. The dirty electricity "noise" on the hot and neutral wires then cancel each other out to a certain degree. Capacitive filters can mitigate dirty electricity across a broad range of frequencies and should be installed as close to dirty electricity sources as possible to be most effective. Some capacitive filters plug directly into electrical outlets and can be installed by any adult, while others must be installed at your main electrical panel by a licensed electrician. Most dirty electricity filters currently available for use in homes, schools, and businesses are capacitive filters.

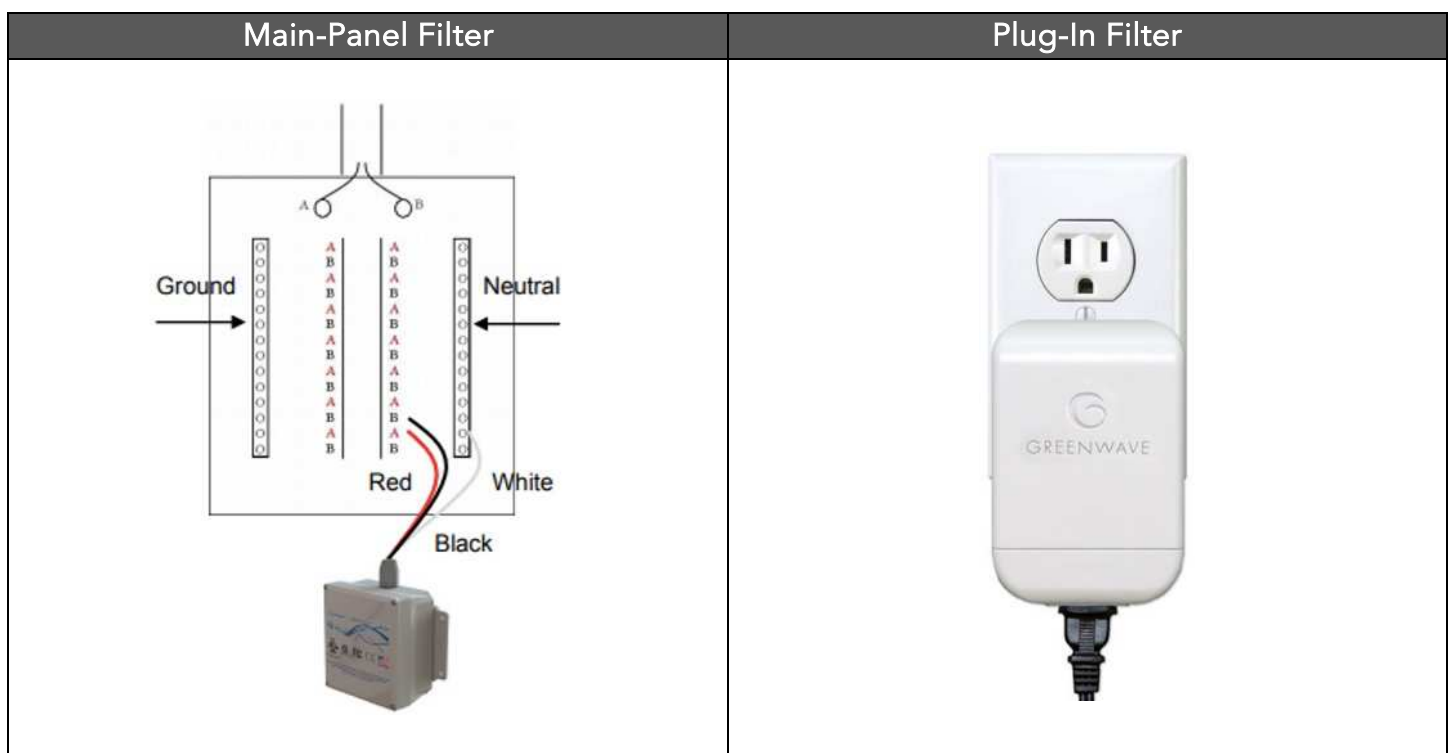
2. INDUCTIVE Filters

Inductive filters are installed "in series" (inline) and work by "choking" high frequency CURRENT. Basically, they make it difficult for this current to move through circuits at all. Inductive filters are also effective across a broad frequency range. Unlike capacitive filters, they can be installed anywhere in circuits with dirty electricity (not just close to sources) to be effective. Inductive filters are usually more expensive than capacitive filters. They are also larger and almost always require installation by a licensed electrician (sometimes also in coordination with the utility company).

Both capacitive and inductive filters have a range of dirty electricity frequencies they are designed to target, which can vary by brand and model. Generally, the filters do a very good job of decreasing dirty electricity within their relatively broad target range. Both types of filters also have the potential to amplify a narrow band of frequencies at the low end of the dirty electricity frequency spectrum if conditions are just right. This potential issue is known as resonance. It's one reason why a dirty electricity reading can occasionally go up rather than down after installing a filter.

General Filter MODELS

There are TWO general models of dirty electricity filters used in homes and other buildings: 1) main-panel filters and 2) plug-in filters. Both will be described in more detail below. The following illustration shows an example of each.



Main-Panel Filters

As their name implies, these dirty electricity filters get wired directly into your main electrical panel. Most popular main-panel filters currently available for homes are CAPACITIVE. These filters can be very good at mitigating dirty electricity as it enters your panel via the two supply lines that “feed” it electricity from the power grid. This helps prevent dirty electricity from neighbors and other external sources from distributing itself widely amongst the electrical circuits in your home.

- CAPACITIVE main-panel filters can also filter dirty electricity generated by loads inside a home, but typically not until that electrical noise gets back to the panel from various locations in the house where it was generated. As the dirty electricity travels back from these locations to the panel, it will radiate into rooms along the way. This is why plug-in filters are sometimes used to supplement a capacitive main-panel filter. Plug-in filters installed very close to INTERNAL (inside) sources of dirty electricity can help mitigate the electrical noise these sources create before it starts a journey back to your main electrical panel.

In general, capacitive filters are not always compatible with generators used to power homes and other buildings during grid outages. If you have a generator and are considering purchasing a capacitive main-panel filter, it's a good idea to check with the manufacturers of the filter and generator to see if the two products can be used safely together.

- INDUCTIVE main-panel filters get installed "in series" with the two utility supply lines (i.e., legs of power) that "feed" the panel. It's best for them to be installed between your electric meter and main panel. As mentioned previously, inductive filters work by "choking" high frequency current. When installed at your main panel, they create a high frequency "choke" for your entire electrical system, helping prevent dirty electricity from flowing through branch circuits. Inductive main-panel filters tend to be somewhat more effective than capacitive models, but are usually a lot more expensive.

Main-panel filters range in price, but tend to be considerably more expensive than their plug-in counterparts. Sometimes two filters are needed, one for each utility supply line entering the panel. When purchasing a main-panel filter (or two if necessary), it's important to select an option that is safety certified (e.g., UL or the like). For safety reasons, it's also important for these filters to be installed by a licensed electrician.

Plug-In Filters

Plug-in dirty electricity filters are relatively easy to use. They plug directly into electrical outlets inside a home and mitigate the dirty electricity flowing along nearby wiring. Plug-in filters can also be installed in dedicated outlets right next to your main electrical panel to "mimic" a main-panel filter at a more reasonable cost. (This option is described in a bit more detail on pages 34-35.)

Plug-in filters are NOT required in every electrical outlet in a home. In fact, installing them in all outlets is not advised. The actual number of filters needed will depend primarily on the following factors:

- **The amount of dirty electricity being generated by sources INSIDE a home.**

This will be affected directly by the number and types of INTERNAL dirty electricity sources in your space. The more sources you have, the more filters you may need. In addition, some items produce more dirty electricity than others (*for example*: solar panel inverters, high-efficiency furnaces and AC units, variable speed pool and well pumps, electrical vehicle charging stations, smart appliances, air filtration systems, etc.).

- **The amount of EXTERNAL dirty electricity entering a home via power lines and other means.**

Generally speaking, some homes are more likely than others to have significant levels of dirty electricity from external sources, for example homes in heavily populated areas as well as those close to commercial or industrial areas. Homes next to neighbors (or in neighborhoods) with solar power installations also tend to have high levels of dirty electricity. As mentioned previously, you can take dirty electricity measurements to estimate how much dirty electricity you're receiving from neighbors and other external sources. (See pages 15–17 for basic instructions on how to do this.)

On average, most homes typically require 1 or 2 plug-in filters per room. Rooms with a high concentration of dirty electricity sources may require 3 or more filters. A total of 16 – 20 filters is usually sufficient in most average homes. (More filters are typically required in schools and other types of buildings.)

Some plug-in filters include special features, such as a built-in outlet for plug-through convenience. You can plug devices into the built-in outlet to access power if needed. In this way, you don't lose the use of an electrical outlet after plugging a filter into it.

When purchasing plug-in dirty electricity filters, it's important to select a model that is safety certified (e.g., UL, SEMKO, or the like). It's also great to have filters that are RoHS compliant. RoHS regulations restrict the use of specific hazardous materials (e.g., lead, mercury, cadmium, certain phthalates, etc.) in electrical and electronic equipment.

General Installation Tips for Plug-In Filters

Plug-in dirty electricity filters can be installed by any adult and normally come with installation instructions. It's generally advisable to follow these directions and to contact the filter manufacturer if you have questions. That said, here are a few overarching tips we believe are important to keep in mind when installing plug-in filters:

- **It's BEST to take dirty electricity measurements PRIOR TO installing plug-in filters (or any other dirty electricity filters).**

Doing so will provide baseline readings for "BEFORE filter" and "AFTER filter" comparisons and furnish additional information that will be very useful during filter installation. Ideally, the measurement process will include the steps below:

- Estimating the amount of dirty electricity entering your home from EXTERNAL (outside) sources via utility supply lines and other means.
- Taking dirty electricity readings throughout your home to identify rooms or areas where readings are the highest.
- Identifying specific sources of dirty electricity INSIDE your home, especially big "offenders."

You can use a plug-in EMI meter to take measurements (or an oscilloscope if you know how to use one). As mentioned previously, a small battery-operated AM radio is also helpful for identifying sources. (See pages 15 – 19 in this guide for basic information about how to take these measurements using a plug-in EMI meter.)

- Use a plug-in EMI meter (or oscilloscope) to guide filter installation and evaluate results.

Taking measurements throughout the installation process can help you evaluate the effect filters are having on dirty electricity levels on your wiring. It can also help you fine tune your installation efforts. For example, a meter can help you determine the best number of filters to install in each room as well as the best combination of outlets to put them in. It can also help you identify and troubleshoot problems that can occasionally arise during filter installation (e.g., resonance).



- Take both **EXTERNAL** and **INTERNAL** dirty electricity into consideration when installing filters.

As mentioned earlier, the dirty electricity flowing through circuit wiring and power cords in a home often comes from a combination of external and internal sources. Typically, some is created by neighbors and other outside sources and finds its way onto your wiring via power supply lines. The rest is generated by various equipment, appliances, and other devices operating inside your home. It can be important to address both when filtering dirty electricity in your environment.

Addressing EXTERNAL DIRTY ELECTRICITY

- A general process for measuring dirty electricity from external sources is described on pages 15 - 17 of this guide.
- If you have a significant amount of dirty electricity coming in from neighbors and other outside sources, filtering electrical noise directly at your main panel (breaker box) can be really useful. Doing so can help prevent external dirty electricity from spreading throughout your electrical circuits, and can reduce the number of plug-in filters needed in the remainder of your home. You can filter dirty electricity at your main electrical panel with either a “wired-in” main-panel filter or plug-in filters installed in dedicated outlets right next to the panel. (If you opt for a main-panel filter, it should be installed by a licensed electrician.)

Using plug-in filters at your main panel can be effective and less costly than investing in a “wired-in” main-panel option. It typically involves the following steps:

1. Install at least **TWO** 2-socket outlets (on dedicated 120V circuits) **right next to** your main electrical panel. This might require having an electrician or experienced handyman install a few new outlets in that location. If your main electrical panel is outside, these outlets will need to be housed in an appropriate weather proof box.
2. Plug in 1 or 2 dirty electricity filters into each of the outlets (not sockets), using T-shaped plug adapters if necessary.

IMPORTANT:

There are two utility supply lines that feed your main electrical panel. For simplicity, let's call them supply line A and supply line B. Each 120V circuit in your panel is "fed" electricity by either supply line A or supply line B, not both. When installing the extra two (or more) 2-socket outlets next to your panel, it is important that one of the outlets is "fed" electricity by supply line A and the other by supply line B. This way, when you plug filters into the outlets, you will be filtering both supply lines coming into your main panel.

- If you install filters at your main electrical panel, it's always important to compare BEFORE and AFTER dirty electricity readings to evaluate the effect the filters are having.
- If your level of external dirty electricity is only low or moderate, it can still be a good idea to install a plug-in filter or two in existing outlets that are closest to your main electrical panel.

Addressing INTERNAL DIRTY ELECTRICITY

There are different ways to go about installing plug-in filters in outlets around your home. We're not going to provide a specific protocol for doing so in this guide. Instead, here are a few basic tips to keep in mind when plugging filters into outlets.

- **Before installing plug-in filters, it's best to turn ON electronics and other AC powered equipment, appliances, and devices you use regularly.**

Refer back to the list of common dirty electricity sources on page 7 of this guide for ideas of items to turn ON. For potentially large sources of dirty electricity such as furnaces, air conditioners, solar inverters, electric vehicle charging stations, pool pumps, well pumps, etc., it's particularly important to make sure they are actively running while you're installing filters. Sometimes this requires adjusting temperature or other settings to intentionally "kick" these items on.

The idea here is to simulate typical levels of dirty electricity in your environment. This will help ensure that you install enough filters to handle the amount of dirty electricity you normally have.

- **It's generally best to start installation in rooms with the most dirty electricity (DE) sources and the highest DE readings.** Tackling these areas first can help reduce the number of filters you need in other areas of your home.
- **Install filters in outlets AS CLOSE AS POSSIBLE to known sources of dirty electricity.** The less distance dirty electricity has to travel to get to a filter, the more quickly it's mitigated.

- While installing filters in outlets around your home, it’s a good idea to take “BEFORE filter” and “AFTER filter” readings as you go to ensure that filters are having the intended effect. (Take readings in every outlet in a room even though you’re not installing filters in all of them.)
- Install only the number of filters needed to achieve reasonable results. (Filters are not needed in every outlet and that approach is not advised.)

As people try to reach the target level of dirty electricity recommended in filter instructions, they are sometimes tempted to plug filters into more and more outlets. There comes a point of diminishing returns during installation, where plugging in more filters does not yield better results and can be counterproductive. While reaching target levels is ideal, it’s not achievable in every environment. It’s acceptable if you’re getting good reduction, but can’t get all the way down to the target level.

A good general rule of thumb is to make sure that each filter installed decreases dirty electricity by at least 20%. If plugging a filter into a particular outlet does not decrease dirty electricity by 20% or more, unplug the filter and move to the next outlet and try again.

You can use the formula below to calculate the percent change a filter makes.

Formula for Calculating Percent Change

Step 1: AFTER reading minus BEFORE reading.

Step 2: Result from Step 1 divided by BEFORE reading.

Step 3: Result from Step 2 multiplied by 100.

For example...

If my dirty electricity reading “before” plugging a filter into an outlet was 200 millivolts (mV) and my reading “after” plugging the filter in is 60 millivolts (mV), I would calculate the percent change as follows:

- Step 1: $60 \text{ mV} - 200 \text{ mV} = -140 \text{ mV}$
- Step 2: $-140 \text{ mV} \div 200 \text{ mV} = -0.7$
- Step 3: $-0.7 \times 100 = -70\%$
- **The percent change is – 70%.**
(This is a 70% reduction.)

- Certain kinds of outlets require special consideration during installation. These include kitchen outlets and switch-controlled outlets.

KITCHEN OUTLETS

In kitchen outlets, especially those directly above the countertop, it's common for each of the two sockets in an outlet to be fed by a different supply line (leg) of power. The top socket may be fed by supply line (leg) A, while the bottom socket is powered by supply line (leg) B, or vice versa. The two sockets may also share a neutral wire. When installing dirty electricity filters in this type of outlet, it is usually necessary to install filters in both the top and bottom sockets. Installing a filter in only one of the sockets may increase rather than decrease dirty electricity on nearby wiring.

Sometimes it's a good idea to save the kitchen for last when installing filters. The filters installed in other areas of your environment may make fewer filters necessary in the kitchen.

SWITCH-CONTROLLED OUTLETS

In some 2-socket outlets, power to one of the sockets can be turned ON and OFF with a switch (usually on the wall). When installing a filter in this type of outlet, make sure to plug the filter into the socket that is always ON, in other words, the outlet NOT controlled by the switch. Plugging a filter into the socket that is always "live" (ON) will ensure that the filter can access electricity to do its job.

SPECIAL CONSIDERATIONS WITH PLUG-IN FILTERS

There are a few special considerations to keep in mind when using plug-in dirty electricity filters.

- **Plug-in filters emit a localized AC magnetic field.**

Like MANY electric and electronic devices we use today, plug-in dirty electricity filters emit a very **localized** AC magnetic field when plugged in and running. This localized field usually extends only 3 – 12 inches from the filter into a room. The field is strongest right next to the filter and decreases very rapidly as you move away from it. When you are about 12 inches from a filter (at most), you are typically out of its localized magnetic field. With this in mind, it's generally best to install plug-in filters in outlets that are at least a foot from places where you stand, sit, or lie down for extended periods of time.

NOTE: Main-panel filters also emit a localized AC magnetic field, but are typically located farther from areas where people spend time. That said, if your main electrical panel or any subpanels are located close to specific areas where you spend significant time, be aware that these panels emit a relatively strong AC magnetic field, with or without a main-panel filter. Try to keep appropriate distance between yourself and the panel(s) most of the time.

A Bit More on AC Magnetic Fields

AC magnetic fields are a type of EMF pollution. You can test the strength of the localized magnetic fields emitted by different equipment and appliances (and how rapidly these fields decrease with distance) using a Gaussmeter. It's easy to avoid the localized magnetic field emitted by a piece of equipment by creating appropriate distance between yourself and the equipment. The amount of distance needed will depend on the specific source, the strength of the magnetic field it emits, and the distance it takes for that field to drop back down to "ambient" levels. By "ambient" we mean the normal AC magnetic field level in your environment when you are not right next to a piece of equipment. [The ambient AC magnetic field level in most homes is somewhere between 0.2 and 1 milligauss (mG). Ambient levels higher than that can indicate a larger problem that may need to be addressed.]

A gaussmeter is also helpful for finding evidence of stronger and more widespread AC magnetic fields caused by nearby power lines, wiring errors in your electrical circuits, or current on meter water pipes, cable TV lines, telephone lines, and other "unwanted" places. These types of AC magnetic fields are more serious than the localized fields just described. They don't decrease as rapidly with distance from the source and can affect large areas of a home depending on the particular issue causing the elevated fields.

- **Capacitive plug-in filters should NOT be used in electrical outlets that are part of circuits with known or suspected wiring errors.**

Certain kinds of wiring errors cause elevated AC magnetic fields in homes because they create net current in affected circuits. Examples of such errors include improper neutral-to-neutral and neutral-to-ground connections, as well as improperly wired 3-way (and 4-way) light switches. Appendix C briefly explains why errors like these result in net current and concerning magnetic field levels.

There are two reasons why capacitive plug-in filters should not be plugged into outlets that are part of circuits with wiring errors.

1. Whenever equipment, appliances, or other loads of ANY kind are plugged in and operating on circuits with certain wiring errors, AC magnetic fields will radiate from electrical wiring into rooms. The more loads that are running on these circuits, the higher the resultant magnetic fields can be. Loads that are ON and running all of the time can result in elevated magnetic fields all of the time.

Capacitive filters that plug into outlets have to allow a small amount of electrical current to flow through them (approximately 0.5 – 1 Amp) in order to mitigate the dirty electricity present on the circuit wiring. When they are plugged in, they are always "ON." Like any other electric or electronic device that draws current through a circuit with wiring errors, capacitive plug-in filters can contribute to elevated AC magnetic fields that radiate from wires of affected circuits.

2. Due to their design and how they work, capacitive filters also add a bit of dirty current to the neutral wire in circuits. This can add to the net current that already exists on circuits with wiring errors, which can amplify the magnetic field effect.

Ideally, NO loads – whether they be capacitive plug-in filters or other devices – should be used on circuits with wiring errors. This is especially true for devices that are always ON or operate for long periods of time. **If wiring errors exist, they should be traced and fixed, particularly if they affect areas of a home (or other building) where people spend a lot of time.** This typically involves the help of an EMF professional and a licensed electrician.

- **Similarly, it's best not to use capacitive plug-in filters if you've got electrical current flowing in inappropriate places, such as along meter water pipes, gas pipes, cable TV lines, telephone lines, etc.**

Electrical current in homes and other buildings is meant to flow through circuit wires and power cords, NOT along conductive surfaces such as metal water pipes, gas pipes, cable TV lines, telephone lines, etc. Unfortunately, current can sometimes find its way onto these inappropriate surfaces. When it does, the result is elevated AC magnetic fields in rooms along the path(s) that these items (pipes, cable TV line, etc.) take through a building. *(This issue is described in a bit more detail in Appendix C.)*

If this issue exists in a home, it's possible for capacitive plug-in filters to add some dirty current to metal pipes or other "unwanted" places, potentially amplifying the already existing magnetic field problem. Other AC powered electric and electronic devices can also add current to these spots, with similar effects on magnetic fields.

If it exists, current on metal water pipes, gas pipes, cable TV lines, telephone lines, etc. is another problem that should be addressed in homes and other buildings to prevent elevated AC magnetic fields at 50/60 Hz and higher (dirty) frequencies.

- **Capacitive plug-in filters can be INCOMPATIBLE with generators used to provide electricity during power outages.**

To avoid possible damage to your generator, filters, and other equipment/appliances/systems in your environment, capacitive plug-in filters should be unplugged when a generator is operating. They can be reinstalled when grid power has been restored and the generator has been turned OFF.

- **Use of capacitive plug-in filters is not recommended in homes with OFF-GRID solar power (or wind power) installations.**

Summary

There are advantages and some potential disadvantages to using filters to mitigate dirty electricity. While they are not a perfect solution, dirty electricity filters are often an important component of an overall plan for effectively reducing this type of EMF pollution in home and other settings.

GREENWAVE FILTERS

- **Easy to use!**

Simply plug them into electrical outlets to filter dirty electricity on nearby wiring.

- **Utilize capacitive technology to mitigate dirty electricity.**

- **Target a broad range of dirty electricity frequencies.**

[Approximately 4 kHz – 10,000 kHz (i.e., 10 MHz)]

- **Available with a 3-prong plug (grounded) or 2-prong plug (ungrounded).**

- **Include a built-in outlet for plug-through convenience.**

- **Meet rigorous safety and environmental standards (UL, CE, SEMKO, RoHs).**



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APPENDIX A

Common Types of EMF Pollution

EMF pollution refers to artificial (human-made) forms of electromagnetic energy. You can't see or smell this kind of pollution, but these days, it's around us nearly all of the time. EMF pollution first emerged with the roll out of AC electricity in homes and other buildings (starting around 1900). It's grown at a breathtaking pace since then, especially since the 1980s. This rapid growth is due in large part to our increasing use of and dependence on wireless technologies, modern electronics, energy-efficient equipment and lighting, and alternative energy systems (e.g., solar power) in homes and other buildings.

Prior to 1900 or so, the only types of electromagnetic fields and radiation (EMF/EMR) that humans and other living things encountered were those found in nature (e.g., sunlight, Earth's magnetic field, and lightning). Since then, our electromagnetic environment has changed DRAMATICALLY. So much so, that some experts estimate we are now exposed to levels of EMF/EMR that are billions of times (or more) greater than what our ancestors experienced just 100 years ago. We've moved from a world in which we were bathed only in natural forms of EMF to one in which we're immersed in a "smog" of artificial electromagnetic radiation 24/7. That's a huge change in a short period of human history!

FIVE types of EMF pollution are now common in and around homes, schools, businesses, and more. The first four are associated with our use of AC (alternating current) electricity. The fifth is related to ALL wireless devices and technology as well as microwave ovens.

1. **AC Electric Fields** (50/60 Hertz)
2. **AC Magnetic Fields** (50/60 Hertz)
3. **Dirty Electricity**
4. **Ground Current**
5. **Wireless Radiation**
(a.k.a. Radio Frequency Radiation, Microwave Radiation)

Unfortunately, a growing body of scientific and clinical evidence points to concerning connections between EMF pollution (artificial electromagnetic fields/radiation) and a wide variety of biological effects and health problems, including DNA damage, oxidative stress, mitochondrial dysfunction, inflammation, cancer, heart disease, diabetes, Alzheimer's, ALS (Lou Gehrig's disease), autism, ADD/ADHD, infertility, sleep problems, chronic fatigue, headaches, muscle and joint pain, and mood issues (e.g., irritability, anxiety, and depression) to name just a few.

Current safety standards related to non-ionizing EMF/EMR are not sufficiently protective and need to be changed. That could take a while. Fortunately, while we wait for better standards and safer products, there are steps we can take to measure our EMF exposures and protect ourselves against this fast-growing form of pollution at home and other places.

APPENDIX B

Suitable Instruments for Measuring Dirty Electricity

The information below briefly outlines instruments that are suitable for measuring dirty electricity, as well as those that are less suitable or useful at this time (with some exceptions).

Suitable Measurement Instruments

For measuring the dirty electricity flowing along electrical wiring in circuits

- **Oscilloscope**

Oscilloscopes can provide the most comprehensive and accurate information about the dirty electricity flowing along building wires. They can measure dirty electricity riding on top of both the VOLTAGE and CURRENT waveforms of conventional 50/60 Hz electricity. They are able to detect a broad range of dirty electricity frequencies, including a majority of those commonly found on electrical wiring today. Unfortunately, oscilloscopes are complicated to use, typically requiring significant expertise and experience to operate and interpret properly. They can also be expensive and often require peripheral parts or other equipment to function most effectively.

- **Plug-In EMI Meters**

(a.k.a Line Noise Meter and Microsurge Meter)

Plug-in EMI meters provide an easier way to measure the dirty electricity present on building wires. They are equipped with a cord that plugs directly into electrical outlets. Simply plug these meters into outlets to measure the level of dirty electricity flowing along nearby wiring. Plug-in meters measure the dirty electricity riding on top of the VOLTAGE waveform of conventional 50/60 Hz electricity. The frequency range covered by these meters varies by manufacturer. It is not as broad as the frequency range of oscilloscopes, but typically covers an important band of traditional dirty electricity noise found on electrical wiring. When choosing a plug-in EMI meter, it's generally advisable to select a model that can detect dirty electricity frequencies from around 5 kilohertz (or lower) to 1 megahertz (MHz). This will help ensure that you are able to detect most common dirty electricity frequencies.

Different EMI meters use different measurement units to report dirty electricity readings (*for example:* millivolts or GS units). The manufacturers of plug-in meters typically provide a target dirty electricity level. You can compare your readings to the recommended target to determine whether dirty electricity levels in your environment may be higher than desirable.

(continued on next page)

APPENDIX B

(continued)

Suitable Measurement Tools

For measuring dirty electricity fields in the air – a.k.a. “radiated” dirty electricity

- **Oscilloscope Outfitted with Special Antenna**

An oscilloscope equipped with a special antenna can be used to measure dirty electricity fields that have radiated into rooms from electrical wiring, power cords, and AC powered devices. Oscilloscopes can provide detailed information about radiated dirty electricity, but as explained earlier are complicated to use and typically require expertise and experience to operate effectively.

- **Portable, Battery-Operated AM Radio**

A battery-operated AM radio without noise suppression technology can be a very helpful tool for detecting the presence of dirty electricity fields and identifying sources in homes and other settings. The downside is that a radio cannot “quantify” the levels (or strength) of dirty electricity in your environment. In other words, it cannot produce specific measurements that can be compared to recommended target levels.

Less Suitable (or Unsuitable) Measurement Instruments

Many people try to use AC electric field meters, AC magnetic field meters (gaussmeters), and radio frequency (RF) meters to measure dirty electricity fields in the air (i.e., “radiated” dirty electricity). For a variety of reasons, these types of meters are NOT currently suitable for measuring dirty electricity in useful ways. (There are some exceptions, one of which will be described later in this appendix.)

- **AC Electric and Magnetic Field Meters**

There are many consumer-level meters available for measuring AC electric and magnetic fields present “in the air.” These meters can be very effective for measuring the fields associated with conventional 50/60 Hz electricity. In theory, they should be equally effective for measuring and reporting the higher frequency electric and magnetic fields associated with dirty electricity. Unfortunately, they are not. The problem lies in some limitations of the AC electric and magnetic field meters currently available, especially inexpensive consumer-level models. Three of these limitations are described below.

- **The frequency range covered by many AC electric and magnetic field meters include only a limited subset of the dirty electricity frequencies commonly found on electrical wiring today.**

For example, an electric field meter with a frequency range of 50 Hertz (Hz) – 50 kilohertz (kHz) will be unable to detect dirty electricity fields with frequencies above 50 kHz, which are quite common. Similarly, a meter with a frequency range of 40 – 100 kilohertz (kHz) will miss dirty electricity fields below 40 kHz and above 100 kHz, which are also common.

- **Most AC electric and magnetic field meters are NOT able to measure dirty electricity frequencies independent of (i.e., separate from) the 50/60 Hz AC fields associated with conventional electricity.**

For example...

Electric fields from different sources oscillate at different frequencies. Electric fields from conventional AC electricity oscillate at 50 Hz or 60 Hz, while those from dirty electricity oscillate at a variety of higher frequencies (usual in the kHz range of the electromagnetic spectrum). In a typical room, there can be a variety of AC electric fields at different frequencies present simultaneously.

A typical consumer-level AC electric field meter will look at all of the electric fields in a room within the specific frequency range covered by the meter. It will consider the strength of each electric field present and combine these different field strengths together (in some way) to provide an overall reading. *Why is this a problem when it comes to measuring dirty electricity?*

When using this type of meter, you won't know how much of the overall electric field strength in a room is from conventional electricity (50/60 Hz) and how much is from dirty electricity (higher frequencies). Not knowing the strength of JUST the higher frequency electric fields from dirty electricity makes it impossible to compare your radiated levels to recommended levels to determine if they are higher than desirable.

For similar reasons, it's also very difficult to use most AC electric field meters to identify sources of dirty electricity or gauge the effectiveness of mitigation (reduction) efforts. The 50/60 Hz electric fields from conventional electricity are usually the strongest electric fields in a room and usually make up a majority of the reading reported by an AC electric field meter. Incremental millivolt increases and decreases in dirty electricity can be difficult to detect on a meter with the dominant 50/60 Hz field present in a room. You really need a meter that can measure dirty electricity fields separate from 50/60 Hz fields so that you can see more precisely what your levels are and how they increase or decrease when adding or removing sources.

You may wonder if you need to be concerned about the lower-level electric fields associated with dirty electricity if the 50/60 Hz electric fields are the strongest in a room. The answer is YES. Both types of electric fields can be agitating to our bodies, but dirty electricity fields are believed to be MORE biologically active and potentially detrimental to health due to their higher frequency, non-standard wave form, and chaotic nature.

- **Many AC electric and magnetic field meters, especially AC electric field meters, are not sensitive enough to detect low levels of radiated dirty electricity that are still considered higher than healthy.**

For example, the lowest reading that some popular AC electric field meters can detect and report is 1 Volt per meter (V/m), which is well above average exposure levels recommended for frequencies between 3 kilohertz (kHz) and 3 megahertz (MHz) in the EUROPEAN EMF Guidelines (2016): 0.1 V/m (daytime), 0.01 V/m (night time), and 0.003 V/m for sensitive populations. (*Source: EUROPEAN EMF Guideline 2016 for the Prevention, Diagnosis, and Treatment of EMF-Related Health Problems and Illnesses*)

Ideally you want a meter that is sensitive enough to tell you precisely what your radiated dirty electricity levels are so that you can compare them to recommended levels and decide whether mitigation is necessary and whether reduction efforts are successful.

NOTE: Most of the examples given above referred to AC electric fields and the meters used to measure them. This is because electric fields from dirty electricity are more common in rooms than magnetic fields from dirty electricity. That said, the same general limitations apply to most AC magnetic field meters too.)

One example of an AC electric and magnetic field meter that comes close to being able to measure radiated dirty electricity fields effectively is the Gigahertz Solutions NFA 1000. This combination electric and magnetic field meter covers a wide enough frequency range (5 Hz – 1 MHz) and is able to measure dirty electricity fields separate from the 50/60 Hz fields of conventional electricity. Where it falls just short is its measurement sensitivity. The lowest electric field level the meter is able to detect and report is 0.1 V/m, which is still well above the maximum exposure level of 0.003 Volts/meter recommended in the EUROPEAN EMF Guidelines (2016) for sensitive populations. The NFA is an outstanding meter used by many EMF professionals. Unfortunately, it costs over \$2,000, which makes it unaffordable for most regular folks wanting to measure their EMF exposures at home or other places.

Radio Frequency (RF) Meters

RF meters are not really suitable for measuring traditional dirty electricity fields. They are designed to measure higher frequency radiation from microwave ovens and wireless devices/technology.

APPENDIX C

Elevated AC Magnetic Fields from Wiring Errors and Current Flowing on “Inappropriate” Paths

Wiring errors and current flowing on inappropriate surfaces (*for example*: metal water pipes, gas pipes, cable TV lines, telephone lines, etc.) can cause elevated AC magnetic fields in homes and other buildings, typically at unhealthy levels. Here is bit of BASIC information to help explain why.

Wiring Errors

As background, anytime electrical current flows along a single conductor such as a wire, a magnetic field will radiate from the conductor.

In a properly wired home with “modern” wiring, the amount of electrical current flowing on the hot wire (supply) and on the neutral wire (return) in each circuit will be EQUAL (balanced) when loads are turned ON and running. In other words, there will be no NET current on branch circuits. When this is the case, the AC magnetic fields emitted from the hot wire and from the neutral wire in each circuit will cancel each other out for the most part. The result is NO or very little AC magnetic fields radiating into rooms from the wiring behind walls, above ceilings, etc.

The opposite is true when certain kinds of wiring errors exist in circuits. Examples of such errors include improper neutral-to-neutral and neutral-to-ground connections as well as improperly wired 3-way (or 4-way) light switches. Wiring errors like these cause NET CURRENT on affected circuits. Net current exists when the amount of current flowing through the hot wire in a circuit does NOT equal the amount of current flowing through the neutral wire of the same circuit.

Why does this happen?

As background, all electricity that travels out to lights and other loads on a circuit (via the hot wire) is supposed to travel back to your electrical panel on the neutral wire for the SAME circuit. To repeat (because this is important), there is only ONE “return” path that electricity is supposed to take in a circuit and that is the neutral wire for that circuit. The problem with wiring errors is they create alternate (parallel) paths for electricity to take back to your breaker panel. Or, in other words, one or more paths other than the intended neutral wire. Common examples of alternate paths include a neutral wire for a completely different circuit or a ground wire. Electricity flowing through a circuit will take all available paths back to your main panel, including inappropriate alternate paths if they exist. When some electricity takes one of these alternate return paths, the amount of current on the hot wires and neutral wires for all affected circuits will no longer be equal. Now NET CURRENT exists in these circuits.

When there is NET CURRENT on a circuit, the AC magnetic fields emitted from the hot wire and from the neutral wire will **not** cancel each other out completely. Whenever equipment, appliances, or other loads of ANY kind are plugged in and operating on circuits with net current, AC magnetic fields will radiate from electrical wiring into rooms. The strength of the fields and the distance they extend from wiring will depend on the amount of current flowing through the affected circuits at any given moment. The more loads that are running on these circuits, the higher the resultant magnetic fields can be. Loads that are ON and running all of the time can result in elevated magnetic fields all of the time.

This is not a healthy situation! If wiring errors exist in a home or other building, they should be traced and fixed, particularly if they affect areas of a home (or other building) where people spend a lot of time. This typically involves the help of an EMF professional and a licensed electrician.

NOTES:

By "modern" wiring we mean Romex and other wiring where the hot wire and neutral wire are located right next to each other. "Loads" refer to equipment, appliances, and other devices that run on electricity.

Current on "Unwanted" Paths

Electrical current in homes and other buildings is meant to flow through circuit wires and power cords, NOT along conductive surfaces such as metal water pipes, gas pipes, cable TV lines, telephone lines, etc. Unfortunately, current can sometimes find its way onto these inappropriate surfaces. When it does, the current is flowing in one direction and emitting an AC magnetic field. There is no equal amount of current flowing in the opposite direction to help "cancel" this magnetic field. The result is elevated AC magnetic fields in rooms along the path(s) that these items (e.g., pipes, cable TV lines, etc.) take through a building.

If this problem exists in a home (or other building), it should be addressed to prevent elevated magnetic fields at 50/60 Hz and higher (dirty) frequencies.