Dirty Electricity In Off-Grid Applications

Dirty Electricity From Various Appliances, Solar Cell Inverters and Wind Mill Inverters

By

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1.0 Background

This document describes some aspects of what is called Dirty Electricity. It is mostly oriented to the systems used for off-grid power applications, such as those that employ solar cell arrays and wind mills. Nevertheless, general principles of how Dirty Electricity propagates are included as well.

In this document, the products that our companies produce to mitigate Dirty Electricity will be described.

1.1 What Is Dirty Electricity ?

The term, Dirty Electricity refers-to voltages and currents that are present on the utility power wiring that are **other than**, the intended utility power.

In the U.S. the utility power is at a frequency of 60 Hz (Hertz, i.e. cycles per second).
In Europe the utility power is at a frequency of 50 Hz.

Dirty Electricity voltages and currents are typically frequencies that are **higher than** the power line frequencies.

While there is no official definition of Dirty Electricity, an analysis of the Dirty Electricity energy that is present on various power circuits (residential, commercial and industrial) will usually show that most of this Dirty Electricity energy is in the frequency range of:

5KHz (5,000 Hz) to 1 MHz (1,000,000 Hz).

It should be noted though, that Dirty Electricity can be any frequency, so 500 Hz, 2 Khz or other such very low frequencies that are **other than** the basic power line frequency (50 Hz or 60 Hz) would be called Dirty Electricity.

1.2 The Problem With Dirty Electricity

1.2.1 Voltage Creates An Electric Field

Any voltage present on a conductor, or any object, will have a corresponding Electric Field associated with it. If the voltage is varying - an AC voltage - then the corresponding Electric Field will vary. This varying Electric Field will propagate, outwards from the conductor (or object) through space. This is referred-to as "radiation".

1.2.2 Current Creates A Magnetic Field

Any current flowing through a conductor, will have a corresponding Magnetic Field associated with it. If the current is varying - an AC current - then the corresponding Magnetic Field will vary. This

varying Magnetic Field will propagate, outwards from the conductor through space. This also is referred-to as "radiation".

1.2.3 Fields Cause Induction

A **varying Electric or Magnetic Field will induce a voltage or current into any object or conductor** that is within that field, if the material of that conductor/object is conductive to electricity.

This reference to: "object or conductor", includes the human body.

As a result, Dirty Electricity present on the utility power circuits will produce fields, in the vicinity of the utility wiring, and those fields will induce voltages and/or currents into the human body.

Here is an important note about the use of the word "vicinity" in the above sentence.

The discipline of Physics and Electrical Engineering that addresses how voltages and currents produce fields and how fields induce voltages and currents is called: Field Theory. It is mature both in theory (Physics) and application (Electrical Engineering).

There appears to be something of an "urban legend" in regard-to Dirty Electricity Magnetic Fields. Specifically there appears to be some belief that the Dirty Electricity Magnetic Field radiation from utility wiring falls off to "nothing" after a few inches. **This is an entirely incorrect statement**.

The strength of the Magnetic Field will fall off (decrease in strength) is a similar way to an Electric Field. Field Theory will predict this. A Magnetic Field does not magically become nothing. It does not just go away. Said another way - if you are concerned about the effect of Dirty Electricity on the human body, then you can't ignore Dirty Electricity Magnetic Fields.

1.2.4 Dirty Electricity Research On Human Health

There is a vast body of research that demonstrates ill health effects from Dirty Electricity fields.

Just a small example of this research, from highly credentialed individuals who have published their papers in referred journals, can be found at:
http://www.rfreduce.com/robertsblog/research

1.3 Sources Of Dirty Electricity

This paper is oriented to the off-grid power system area, but in the following listing of Dirty Electricity sources, all common sources will be mentioned. The listing is not presented as exhaustive.

1. **Dirty Electricity from switch mode power supplies that power various electronics that are connected to the A.C. line**, including digital utility monitoring meters, often called "Digital Meters", digital utility monitoring meters that transmit their metering information wirelessly to central collection points, often called "Smart Meters", (**see Utility Meters note below**), computers, office machines, uninterruptible power supplies (UPS), entertainment electronics, etc. In addition to these Dirty Electricity voltages and currents causing Dirty Electricity fields within the facility where they are generated, the Dirty Electricity voltages and currents will also, to a degree, travel out of the home/facility into "the street" and from there it will travel, to a degree, into other homes/facilities and thereby produce Dirty Electricity fields in those other locations.
2. **Dirty electricity from the type of switch mode converter called an "inverter".** An inverter takes a DC (direct current) power source and turns it into some frequency of AC (alternating current), typically 60 Hz (U.S.) or 50 Hz (Europe). In off-grid applications where a solar cell array or wind mill are used to generate power, this power is often DC. Since most appliances are AC, an inverter can be used to create the AC so that the appliances can use the power. To be efficient in this "inversion" process, a switching type of circuit is used and this type of circuit will generate Dirty Electricity and will feed a portion of that Dirty Electricity back onto the 60 Hz (or 50 Hz) power lines. Then this Dirty Electricity will travel throughout the wiring infrastructure of the home, business or factory and radiate those Dirty Electricity frequencies into the areas occupied by people. In addition, the Dirty Electricity will also, to a degree, travel out of the home/facility into "the street" and from there it will travel, to a degree, into other homes/facilities and thereby produce Dirty Electricity fields in those other locations.
3. **Harmonics from traditional power supplies (not switch mode supplies)** that power various electronics, noted above.
4. **Harmonics produced in the utility network itself from various sources, most notably, BH curve non-linearity's in transformers** from being operated too close to their maximum ratings, i.e. driven close-to or into saturation.
5. **Harmonics produced in the utility network from the turn on surges of the customer's equipment, can drive transformers into saturation**. This is a sporadic generation of Dirty Electricity/harmonics, but is a severe-enough problem to be a special note.
6. **Harmonics from electrical motors**.
7. **Broadband Dirty Electricity from electric arc welders**. This is severe, intense Dirty Electricity. In addition to these Dirty Electricity voltages and currents causing Dirty Electricity fields within the facility where they are generated, the Dirty Electricity voltages and currents will also, to a degree, travel out of the home/facility into "the street" and from there it will travel, to a degree, into other homes/facilities and thereby produce Dirty Electricity fields in those other locations.

8. **Broadband Dirty Electricity from induction heaters**. This is severe, intense Dirty Electricity. In addition to these Dirty Electricity voltages and currents causing Dirty Electricity fields within the facility where they are generated, the Dirty Electricity voltages and currents will also, to a degree, travel out of the home/facility into "the street" and from there it will travel, to a degree, into other homes/facilities and thereby produce Dirty Electricity fields in those other locations.
9. **Broadband Dirty Electricity from relay and mechanical switch actuations**, both D.C. and A.C.
10. **Broadband Dirty Electricity and harmonics from motor speed controls, light dimmers** and solid state switches. The latter includes SCR's and Triacs. In addition to these Dirty Electricity voltages and currents causing Dirty Electricity fields within the facility where they are generated, the Dirty Electricity voltages and currents will also, to a degree, travel out of the home/facility into "the street" and from there it will travel, to a degree, into other homes/facilities and thereby produce Dirty Electricity fields in those other locations.
11. **Dirty Electricity from Radio Frequency (RF) transmitters**. There are many devices that employ RF. Remember, RF is simply a subset of EMF. It is, EMF. Among the common examples of RF devices are Wifi routers, cordless telephones, cell phone base stations (aka cell phone towers), cell phone hand sets, BlueTooth-connected computer peripherals such as a mouse or keyboard, etc. What happens here is that the RF radiation will induce itself into (is "happy" to ride upon) any conductor of electricity, including utility power circuits, audio circuits (headphones, microphones, speaker cables, headsets/head pieces for a cell phone or cordless phone, etc.) and others.

NOTE; Utility Meters

In the area of new utility metering deployments (electrical power, gas, water) there are various names and terms used to refer-to these technologies.

Digital Meters

"Digital Meter" often refers-to a utility measuring meter (such as electrical power meter) that has a digital display on the front of it. This digital display is in contrast to the old style "analog meters" that have a series of dials that indicate the energy used.

Since the Digital Meter has electronics within it, it must have a power supply within it as well. Those power supplies are apparently of the "switching" variety. This is evidenced by tests of the power lines that are connected to these meters, where considerable Dirty Electricity has been found. Specifically, Dirty Electricity from the switching power supply.

Smart Meters

"Smart Meters" can be thought of as Digital Meters with a two-way data radio included. So Smart Meters will place Dirty Electricity on the power lines as well as radiate EMF from the data radio.

Understand The Impact of Dirty Electricity In This Setting

The Dirty Electricity is voltages and currents at high switching frequencies (example 20 kHz) that are riding on the wiring, throughout the facility. These voltages and currents radiate Electric fields and Magnetic fields into the living space and those fields induce voltages and currents into the human body.

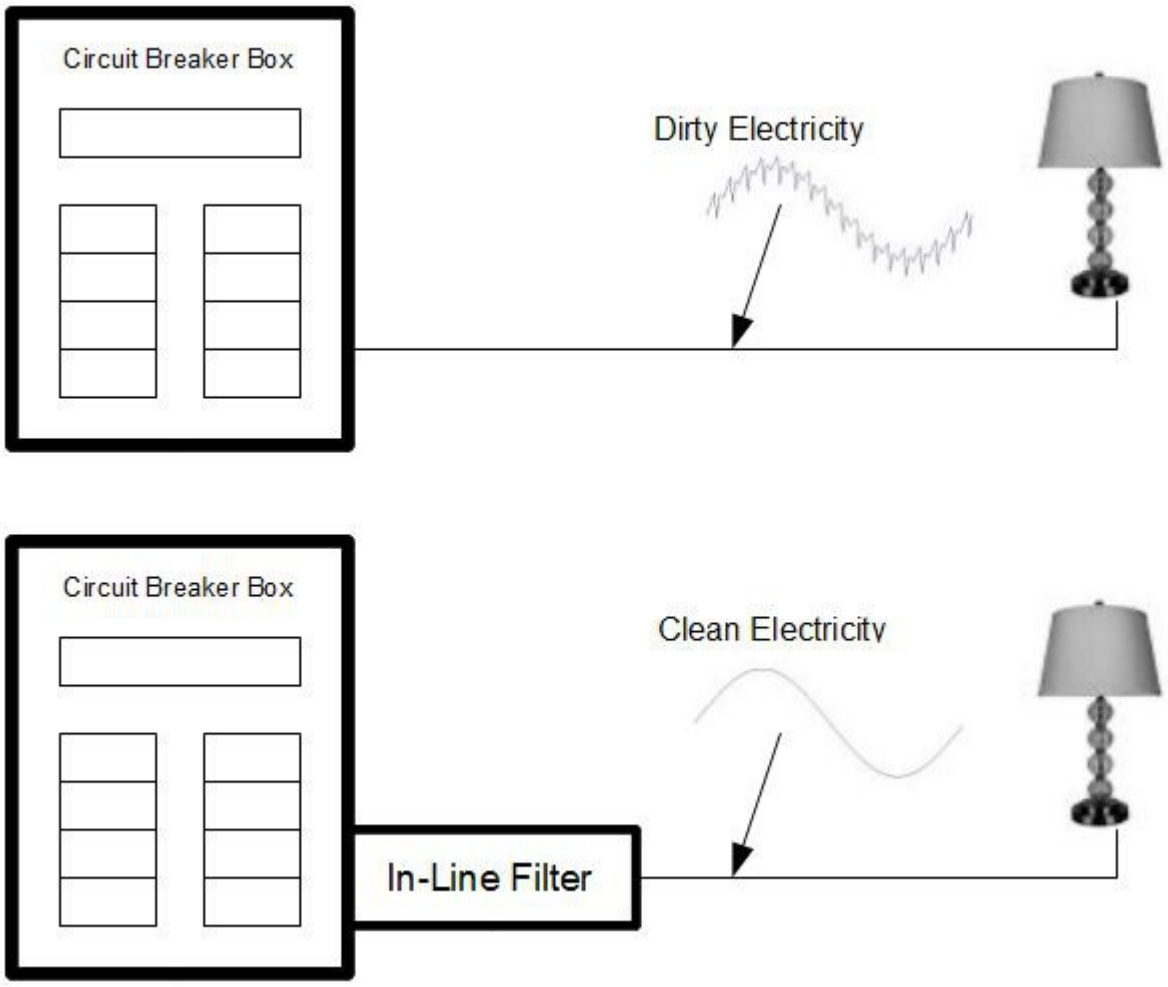
2.0 Reducing Dirty Electricity That Is On The Utility Circuits

2.1 In-Line Filter Approach To Reducing Dirty Electricity

In this approach, the term **in-line** is used, and it means that a device that reduces Dirty Electricity is placed **in-between** the source of Dirty Electricity and the circuits/wiring that one wishes to protect-from Dirty Electricity.

The simplest example might be the following. Assume that the Dirty Electricity is coming into a facility (home, office, factory, etc.) from "the street". It is Dirty Electricity voltages and currents that come into a facility through the main power panel that connects to the incoming power utility circuits. The source of this power might be a power utility provider, or an off-grid power source such as solar cell array or wind mill, etc. The point is that the 60 Hz (or 50 Hz) power has Dirty Electricity along with it.

In the following figure, the use of an in-line filter provides cleaner power to the lamp. While it is shown that the in-line filter is providing power to just one appliance (a lamp), such a filter could be connected into the power circuits of the home/office, etc. so that all of circuits are "cleaned-up".

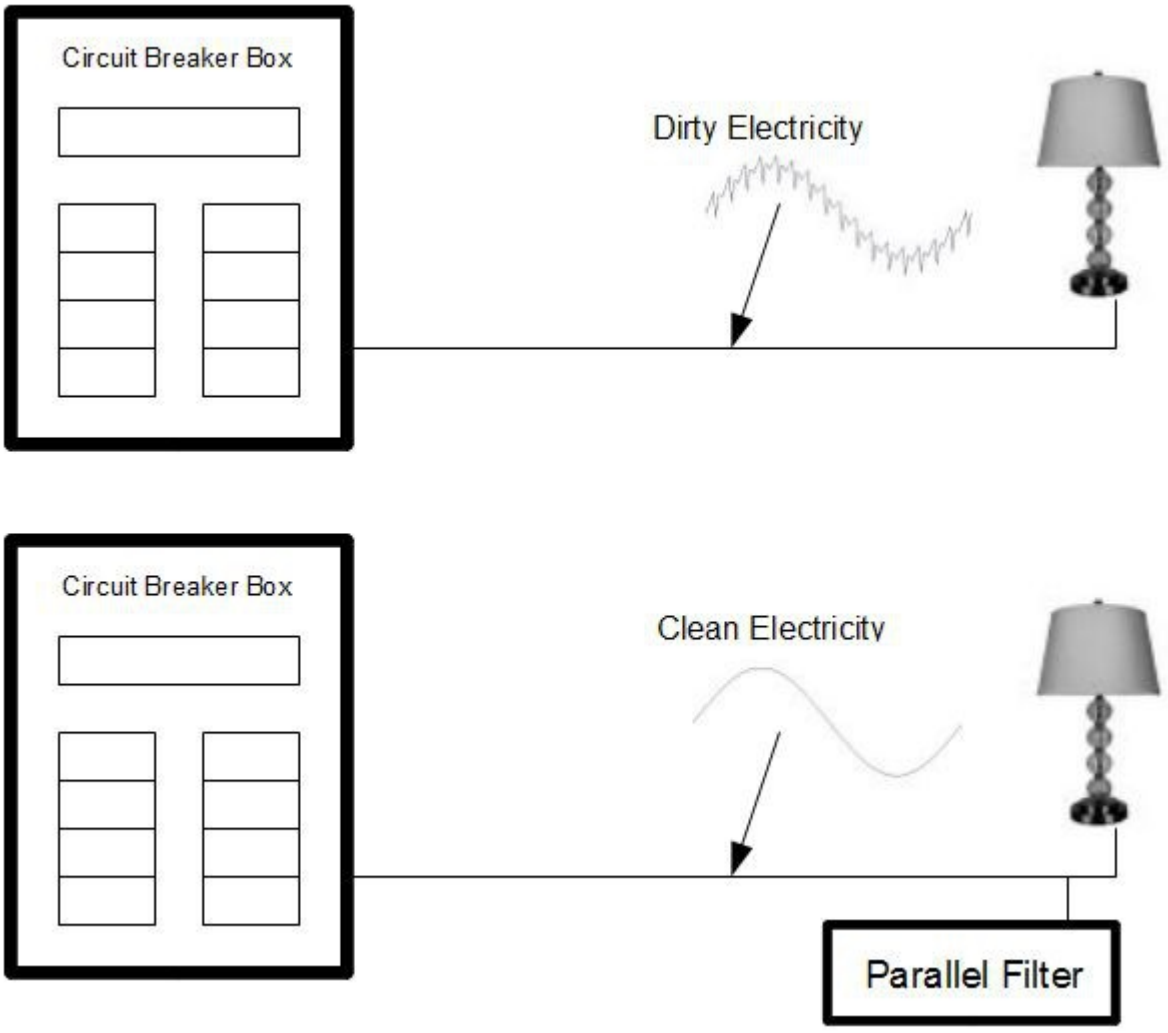


In the above figure, the idea is that before the use of the in-line filter, the Dirty Electricity voltages and currents were coming into the facility (home/business/factory) from "the street" and were radiating from the facility wiring, like the line cord for the lamp, and having an effect on the people in that area.

2.2 Parallel Approach To Reducing Dirty Electricity

An advantage of this **parallel approach** is that it is not necessary to pass all of the utility power through the parallel filtering device. In electronic engineering vernacular, the parallel device is "in parallel with" the various loads, like the lamp. Therefore, the user simply finds an available power utility outlet and "plugs in" the parallel device. Example devices: RxDNA-V2, PxDNA.

The figure below shows the functional connection of a parallel device.



3.0 Reducing Dirty Electricity From Off-Grid Inverters

Background

In pursuit of the goal of a "green Earth", and in pursuit of autonomous, self-sustaining power sources, many people have added wind or solar power collection to their homes and businesses. In some cases solar, wind or other sources are the only source of power and there is no reliance on a utility power company.

Typically these sources of power, (wind solar, etc) produce direct current, DC electricity. Since the vast majority of appliances that people wish to use, are powered from alternating current, AC, then an electronic device is added to the equipment complement to take the DC and produce AC. This device is called an "inverter".

In the US, residential utility power is typically 2 phases of 120 VAC 60 Hz. In Europe and others locations, it is 240 VAC 50 Hz.

In order to be as efficient (with power) as possible, most, if not all, inverters are a "switching" type of design. This switching approach produces unwanted energy at the switching frequency and in addition, produces energy at harmonics of the switching frequency.

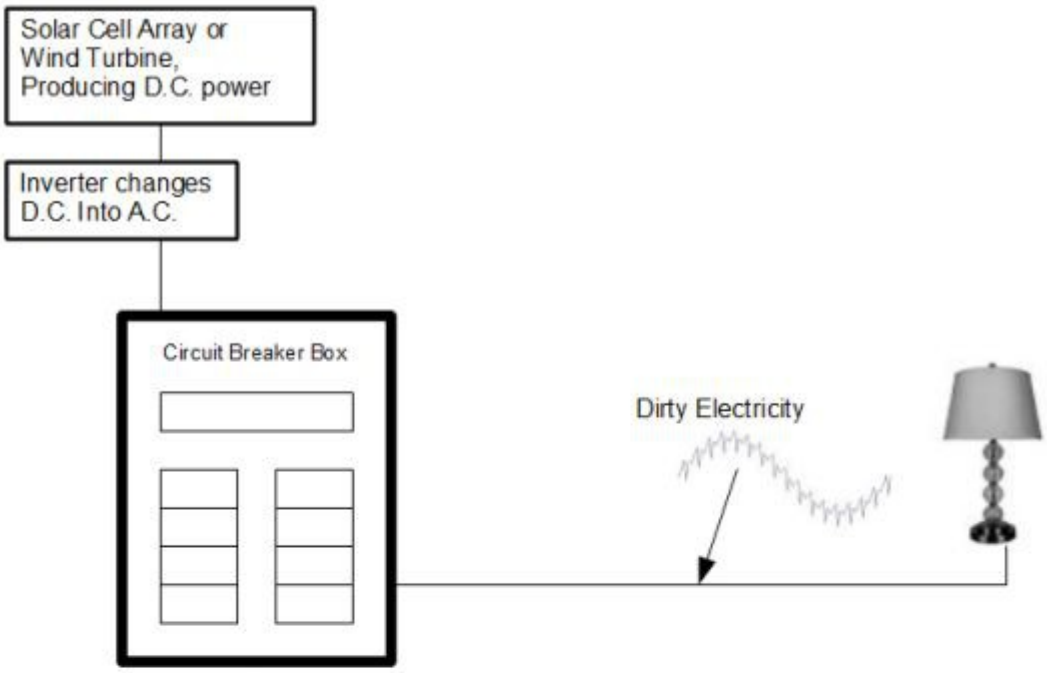
Block Diagrams That Follow

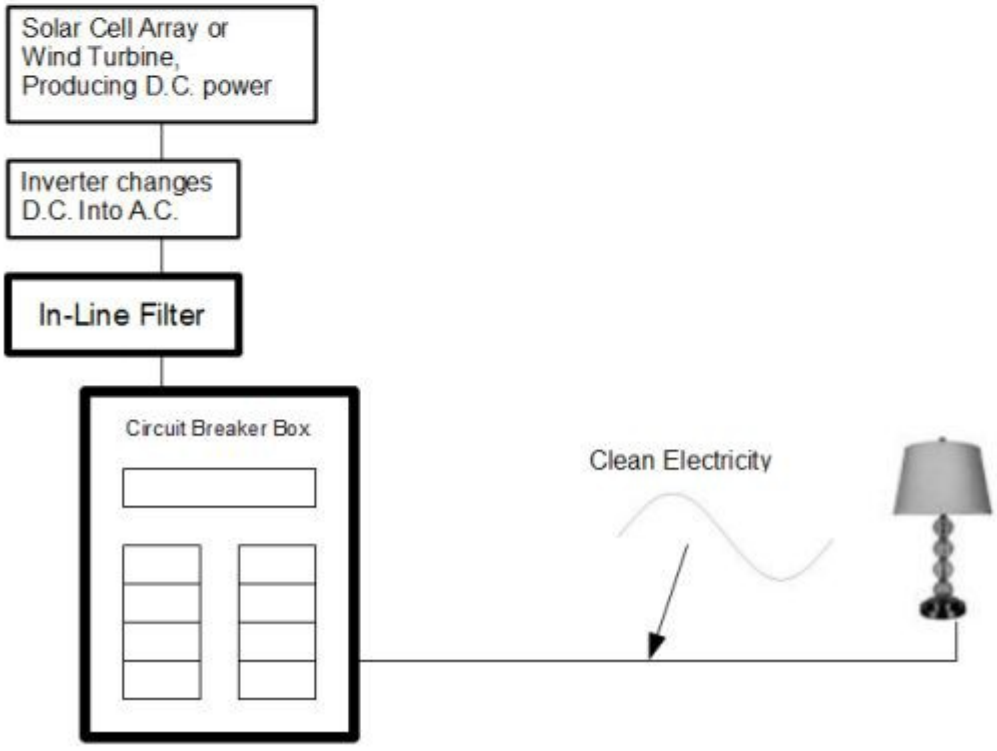
A series of block diagrams follow that show a few of the many possible configurations that are possible to reduce the Dirty Electricity from off-grid systems.

In some applications, the system runs entirely on off-grid (wind, solar, etc) power sources.

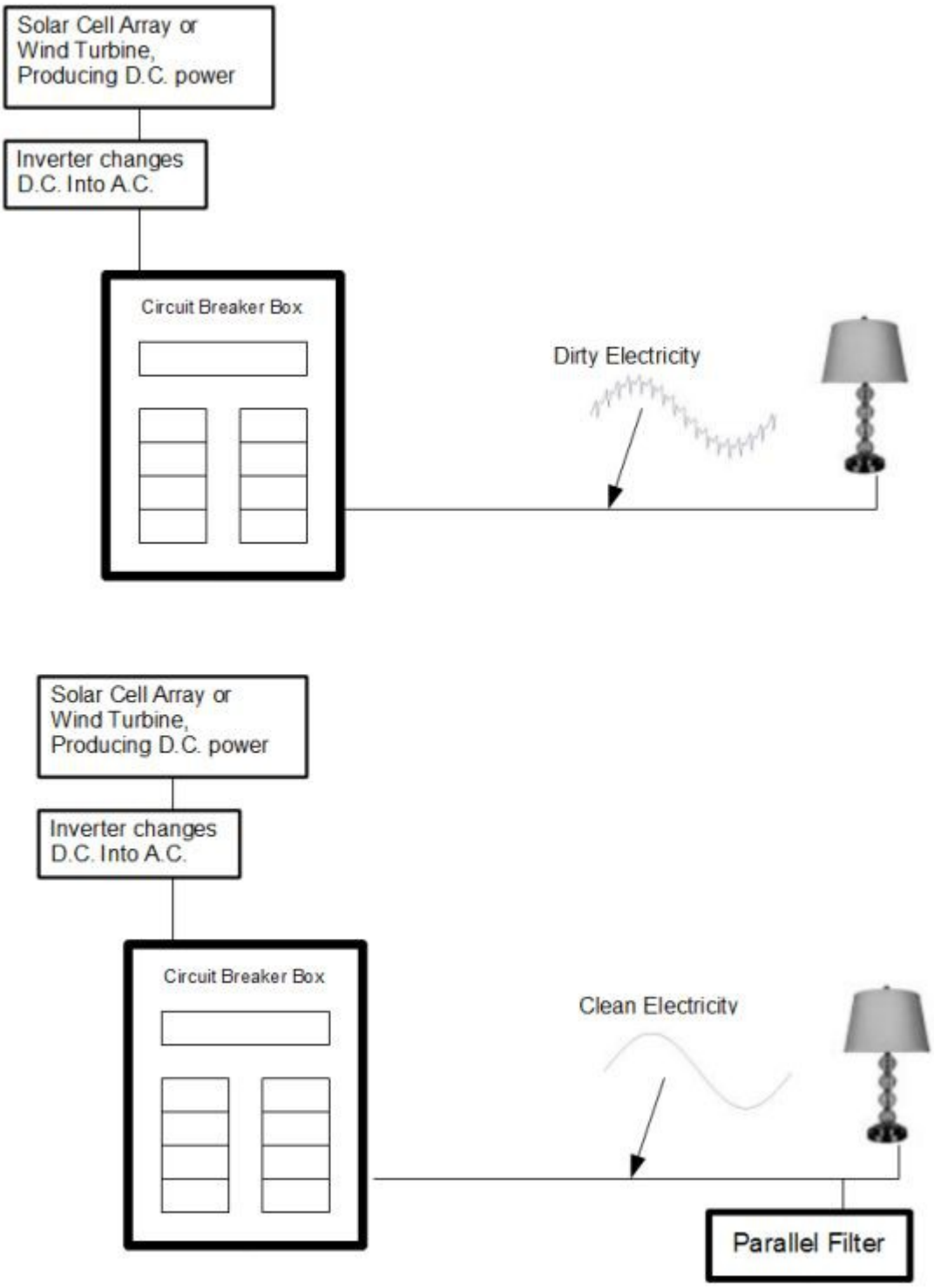
In other applications, the system has both off-grid power as well as power from the public utility provider.

3.1 Off-Grid App: Solar/Wind Is The Only Power Source, In-Line Filter



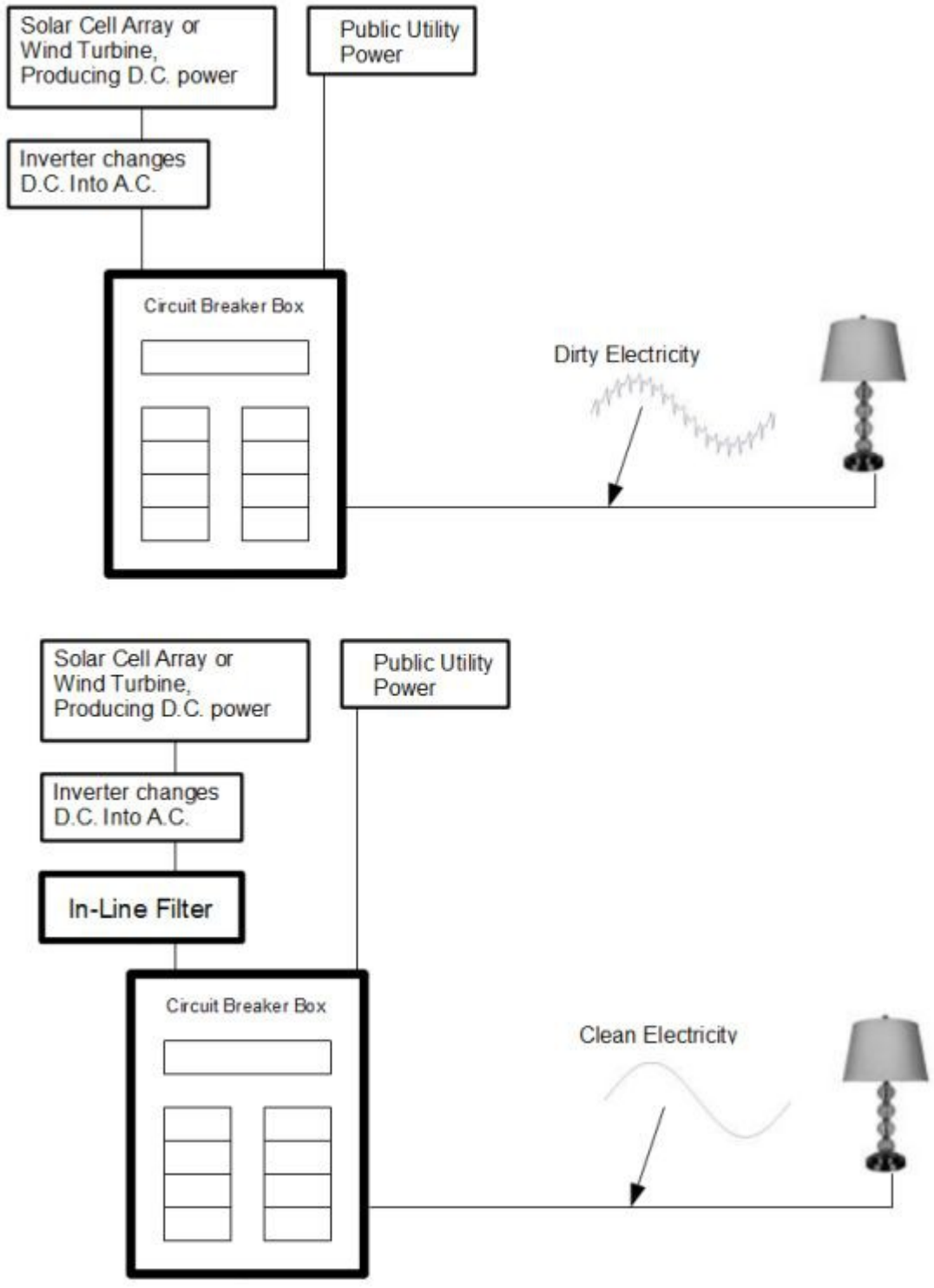


3.2 Off-Grid App: Solar/Wind Is The Only Power Source, Parallel

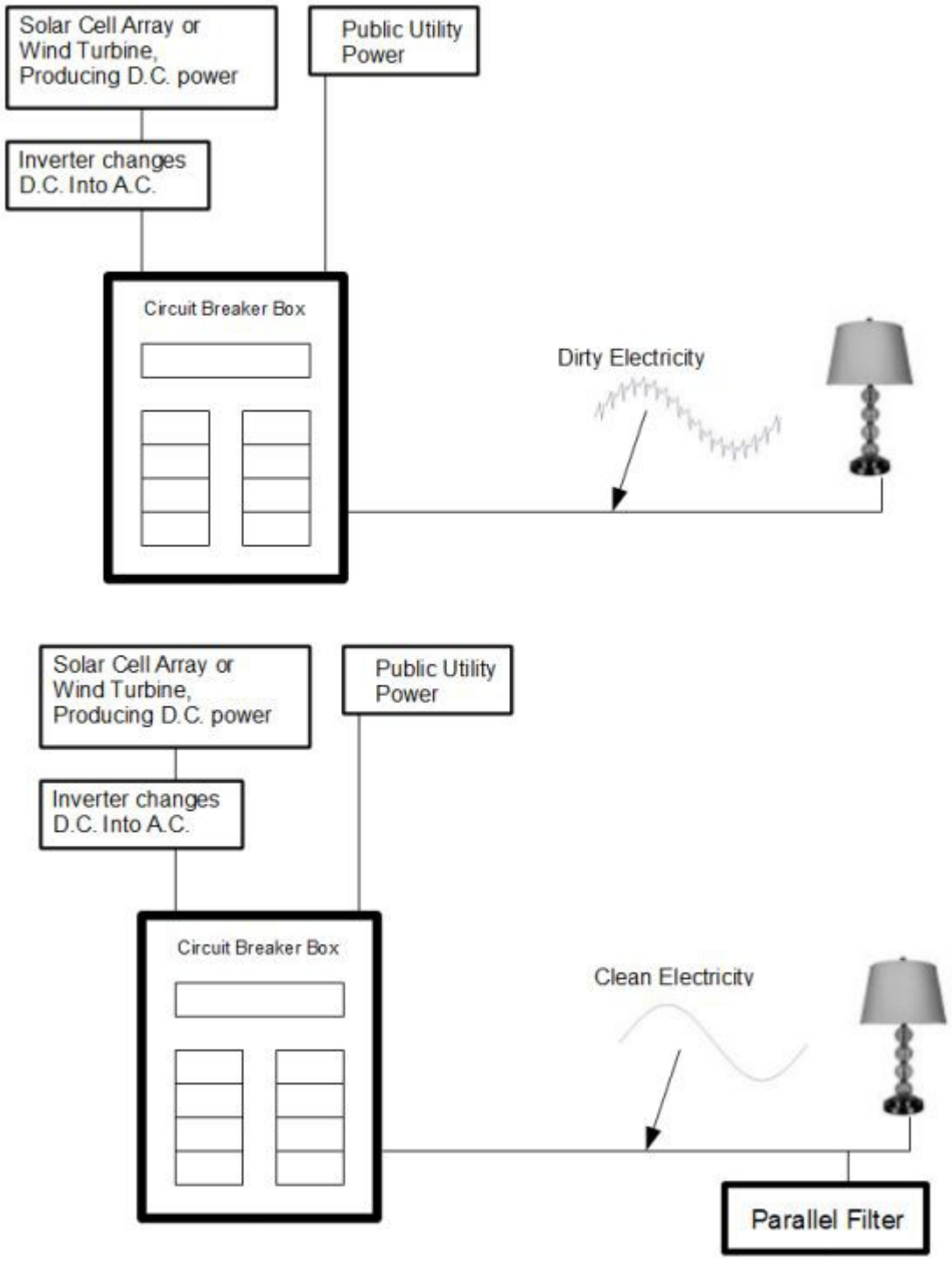


The Parallel Filter could also be installed at the Circuit Breaker Box.
Example devices: RxDNA-V2, PxDNA.

3.3 Off-Grid App: Solar/Wind & Public Utility Power, In-Line Filter



3.4 Off-Grid App: Solar/Wind & Public Utility Power, Parallel Filter



The Parallel Filter could also be installed at the Circuit Breaker Box.
Example devices: RxDNA-V2, PxDNA.

3.5 Some Discussion Of The (above) Figures

Compare Paragraph 3.1 To Paragraph 3.2

The figure of 3.1 shows reducing Dirty Electricity with an **in-line** filter.
The figure of 3.2 shows reducing Dirty Electricity with a **parallel** filter.

Advantages of 3.1 configuration:

1. Greater reduction of Dirty Electricity is achieved with 3.1 (versus 3.2). The 3.1 approach can achieve 500 to 1000 times reduction in Dirty Electricity power, while the 3.2 approach reduces Dirty Electricity power 10 to 30 times.

Advantages of 3.2 configuration:

1. The Parallel device does not have to carry the full 60 Hz (or 50 Hz) power provided by the off-grid system. While the 3.1 approach can achieve significantly greater reduction in Dirty Electricity power, it has to carry the full power that the off-grid system (solar, wind, etc.) is providing. This can be in the range of 10 to 100 amperes (50 Hz or 60 Hz). This requirement makes the in-line unit weigh anywhere in the range of 10 to 70 lbs, whereas the parallel device might be 1 or 2 lbs.

2. The 3.1 configuration will require a professional electrician to install it, while the 3.2 approach is simply the facility (home, office, factory) owner, plugging in the parallel devices to available outlets.

3. The 3.2 parallel approach will also reduce Dirty Electricity that is produced within the facility (home, office, factory) **IMPORTANT NOTE**: This advantage, of 3.2 over the 3.1 is not true for our DNA-Line-Filter product, because the internal architecture of this device has a parallel device on the output circuit. In that way then, it is like an in-line filter and a parallel filter all in one. **The DNA-Line-Filter is actually and in-line filter and the RxDNA-V2 parallel filter, all in one enclosure**.

4.0 Application Discussion

4.1 Source of High Dirty Electricity Readings Prior To Inverter Activation

On occasion, somewhat high Dirty Electricity readings can be discovered prior to connection or activation of the inverters that are a part of an off-grid (solar, wind, etc.) system. This can be due to a variety of reasons, and a document such as this one can only theorize, while an on-site Bau Biologist can "sleuth-out" the real cause or causes. Nevertheless here are just a few possibilities.

1. The inverters in the off-grid system are on/activated, but not "switched into" the system. Depending upon how the system is wired, this could allow the Dirty Electricity to get through into the facility (home, office, factory) wiring and be felt by the occupants. This may not be a strong possibility, though.
2. Solar arrays tend to be an antenna. They can pick up Dirty Electricity fields from other sources in the neighborhood. This may not be a strong possibility, though.
3. There are numerous switching devices in modern HVAC (heating, ventilating, air-conditioning) systems for uses such as: motor speed control. This is always a strong possibility and can be pursued with the installing dealer or HVAC manufacturer.
4. There are a variety of lighting products that use either fluorescent bulbs or LED (light emitting diodes) that typically employ switching regulators. These have historically been notorious sources of Dirty Electricity.
5. There is a type of utility power meter (used by the public utility to measure your energy consumption) that are called "smart meters". They are wirelessly connected to RF (radio frequency) "repeaters" in the neighborhood. They typically operate in the ISM (Industrial Scientific Medical) Band authorized by the FCC. It is usually in the 2.4 Ghz region. Yes, this is the frequency of microwave ovens. While this is not Dirty Electricity per se, it is an EMF (electromagnetic field) radiation and people who are sensitive to Dirty Electricity will generally also "feel" this radiation. It is said to not be Dirty Electricity, because it is radiating directly from an antenna (in the utility power meter) to the person who is feeling it. Now having said that, read the next item in this list.
6. It is possible, and indeed likely that a variety of sources of EMF, in the neighborhood, are actually "coupling" onto the power lines and, as we say in electrical engineering, "going for a ride" on the power lines, or ANY copper wiring for that matter. Indeed, the coupling of EMF onto audio headset wiring of a cell phone is the reason we produce the Noble1 protector (http://rfreduce.com).
7. Even though this may be obvious to you, it is worth saying for completeness, that any Wifi from a wireless router, WiFi from your computer, Bluetooth mouse or keyboard, or any such radiation from your neighbors, will produce EMF fields in your facility. Again, this is not what is called Dirty Electricity, but since this para 4.1 is addressing concerns before activation of off-grid inverters, it is worth mentioning.
8. Finally, there is a type of utility power meter that is in common usage, that has a digital readout. It is not like the old dials-and-gears meter. The meter being referred-to here is not a "smart meter" per se, because it does not have a transmitter in it to broadcast readings. But since it is a digital meter, it needs DC power to run the associated electronics. Typically, if

not always, that DC power supply will be a "switching" type., and it has been documented that they tend to produce a significant amount of Dirty Electricity.

4.2 Choosing A In-Line vs. Parallel Filter For Off-grid Applications

Parallel Devices

Parallel devices such as our RxDNA-V2 or PxDNA are easily to experiment with. The end-user can plug them in and either make readings with an instrument or see "how it feels".

The effectiveness varies from roughly 10-to-1 reduction to roughly 30-to-1 reduction.

In-Line Devices

In-Line devices, in general, will be more effective in reducing off-grid inverter noise, but there is a **HUGE CAVEAT** here. To date, all of the commercially available in-line devices that we have reviewed, only start to attenuate (decrease) the Dirty Electricity ay 50 kHz (50,000 cycles per sec). In the case of an off-grid inverter operating at 16 kHz, this means that such a filter will not provide ANY attenuation of the fundamental Dirty Electricity frequency of 16 kHz, nor the second harmonic (2 x 26 kHz) which is 32 kHz, nor the third harmonic which is 48 kHz. **In these 3 frequency components (16 kHz, 32 kHz, 48 kHz) is the vast proportion of the total of the Dirty Electricity energy produced by the inverter**.

Note that our DNA-Line-Filter has a 500 to 100 times reduction of Dirty Electricity energy at 16 kHz.

In addition, because our DNA-Line-Filter architecture has (internally) a RxDNA-V2 at the output connections, it will act as a parallel device for the facility as well. This means, to a degree, the DNA-Line-Filter will reduce Dirty Electricity that is generated within the facility. For example, the DNA-Line-Filter will reduce, to a degree, the Dirty Electricity produced by a variable speed motor in a HVAC system.

4.3 One Phase vs Two Phase Systems

In a **single phase off-grid system**, a single DNA-Line filter can be effectively used.

In **a two phase off-grid system**, two DNA-Line filters can be effectively used.

In applications where there are multiple solar/wind inverters feeding into a system, multiple DNA-Line-Filters can be used.
For example, if there **are 3 solar arrays, each with a two phase output**, then this can be accommodated by **6 DNA-Line-Filters**.

5.0 Selecting and Installing a DNA-Line-Filter Model

The DNA-Line-Filter products carry the full power line current (50 Hz or 60 Hz) that they are "cleaning". Therefore it is necessary for the end-user to have a professional assess and specify the current that the DNA-Line-Filter needs to carry.

The DNA-Line-Filter is not a do-it-yourself project. It requires a professional to install and wire it into the end-user electrical infrastructure.