Grounding – Why?

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Proper grounding of renewable energy systems may prevent loss of life. Proper grounding may also prevent damage to alternate energy power systems, expensive computers, telephone gear, and ham radio or other communications equipment. Proper grounding can also minimize the electromagnetic emissions from inverters and fluorescent lamps. Proper grounding may be required by law.

Establishing the Requirement

The basic fundamentals of direct and alternating current electricity have been well understood for nearly a hundred years. They apply to alternate energy power systems as well as central power plant systems. Materials, practices, and systems needed to make practical use of electrical energy have changed considerably since the days of Westinghouse and Edison, and they are continually evolving.

The National Electrical Code (NEC), published by the National Fire Protection Association, and numerous documents published by the Institute of Electrical and Electronics Engineers (IEEE) represent the best and most recent thinking on the subject of grounding. Well researched publications by Bechtel Inc. and others provide further substantiation on the need for and methods of grounding.

The Law

In areas of the country covered by the NEC, the law says that all electrical power systems will have exposed, noncurrent-carrying metal surfaces grounded. This ground is called the equipment ground and requires a third, noncurrent-carrying conductor. There are no exceptions for low-voltage, PV, wind, or hydro systems.

If the open-circuit PV module (or hydro voltage or wind generator) voltage exceeds 50 volts (generally any system rated above 24 volts), the NEC requires that one of the current-carrying conductors be grounded. This is known as the system ground.

When one of the current-carrying conductors is grounded (a system ground), surges that are induced on these conductors can quickly discharge to ground through the grounded conductor. If the system is floating with respect to ground with neither of the conductors grounded, then the induced surge of high voltage has no place to go except arc through insulation someplace in the circuit. This arc may damage insulation, and in some cases may start a fire.

These requirements for grounding are not whimsical, nor are they intended to create additional costs, nor are they imposed without thought to electronic or renewable energy systems. They are there for safety -- personnel and equipment. They have evolved over nearly 100 years and the people who establish these requirements work for some of the biggest names in the electrical power and electronics industries. Companies like Westinghouse, General Electric, IBM, and Raytheon among many others, are represented on the panels that write the NEC.

Even in Europe, the ac systems are grounded at the service entrance panel at the residence just as they are in the U.S. Europeans use far more ground-fault detectors and circuit interrupters than we do to find faults on their ungrounded distribution systems. Europeans don't ground some of their alternate energy systems, but standards and codes that are being drafted at this time will address that problem.

Grounding and Electronics

Concern has been expressed that the NEC grounding requirements are not addressing the special requirements of the electronics industry and therefore the needs of the renewable energy user. Anyone who is familiar with computers will know the absolute need for proper grounding. Multiple computers operating with modems and local area networks must have power and communications lines well grounded to the same ground system. Radio Shack sells a device that plugs into the ac outlet and contains modular telephone jacks to keep the ac power and telephone/modem grounds at the same potential and provide surge protection. There is a similar device to tie the ac power ground to the ground on a coaxial cable for antenna systems and radio frequency data communication systems. The telephone company grounds the telephone line to the ac power ground if there

is one.

All "Ham" radio operators know the need for good grounds, not only for maximum performance, but also to control radio frequency interference, and safely contain dangerous currents and voltages. Hams using PV for power may find that their PV systems are grounded through their rigs. If not, they have paid a pretty stiff price for isolated power equipment and antenna arrays.

The ballast found inside an ac fluorescent lamp will be marked; "Use in grounded fixture only." The microwave oven will have a three-bladed plug for proper grounding and it must be used to prevent microwave energy from escaping. Stereo and video systems have one side of the rf, video, and audio connecting cables grounded to the metal chassis. Outside television antennas generally are installed with grounded masts and a grounded surge arrestor is necessary for safest operation. Automobile radios used in PV systems have the negative power lead tied to the chassis as is the shield on the coaxial cable to the antenna. The chassis or antenna may be grounded. The use of any of these dc operated devices probably indicates that the dc system is grounded.

The most popular line of home-power inverters has the negative conductor connected to the case. Ground the chassis and the system is grounded – you have no choice, even on 12 and 24-volt systems where system grounding is not required.

The entire alternating current secondary power distribution system in the United States is grounded (except for 3-phase delta transmission lines). Complete magazines are published monthly dealing with power quality throughout the world. The largest problem area is separately grounded systems that have grown up over the years as various electronic devices have proliferated. The separate grounds being used for each individual system (the telephone system, the computer systems, and the radio communication system) have created quite a mess. Each system requires a ground for proper operation and safety. The best available solution (even Radio Shack knows about it) is to tie all the grounds together at a single point and provide surge protection from each service to the common ground. The NEC requires that all grounds (ac, DC, equipment, and communications) be connected to the same ground rod or if multiple ground rods are used, they be bonded together. The electronics industry who deals with this problem daily completely agrees.

Uninterruptible Power Systems (UPS) is one of the fastest growing industries in the country (far bigger than the PV industry). An UPS is nothing more than a battery bank, a charger, and an inverter with lots of electronics – just like PV. All are well grounded.

Grounding Benefits for Renewable Energy Systems

If PV or other alternate energy systems are properly grounded with both equipment and system grounds, a number of beneficial conditions will occur. Safety will be increased and the legal requirements of the NEC will be met. The system will be less likely to cause fires from short circuits. Radio frequency interference from inverters will be reduced – especially when the battery cables are in grounded metallic conduit. Compact and regular fluorescent lamps will start more reliably and produce less radio frequency interference. (Quicker starting of both ac and DC fluorescent lamps means longer life.)

Systems that are not grounded require two-pole disconnects. The one-pole disconnects allowed in a grounded system save far more money than the cost of the ground rod which had to be used anyway to comply with the equipment grounding requirement. (WARNING: Battery banks, especially those over 50-volts, should have two-pole disconnects in either grounded or ungrounded systems because of the danger from shock due to the electrolyte film and the danger of explosions from hydrogen gas. This is not an NEC requirement, but battery and PV industry personnel recommended it.)

Proper grounding does not cause problems in RE systems. Old stories of wind towers falling down with electrolyzed tower supports have been traced to improper grounding techniques or the use of the metal tower as a current-carrying conductor. Good grounding practices coupled with the proper use of overcurrent devices will provide equipment protection when faults do occur.

In Home Power Magazine 28, grounding methods will be covered.

Access

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Photovoltaic System Grounding and Fault Protection Guidelines, Bechtel, Research and Engineering Operation, San Francisco, CA