光伏发电系统工程师专用词汇

A

Activated Shelf Life The period of time, at a specified temperature, that a charged battery can be stored before its capacity falls to an unusable level.

AIC Amperage interrupt capability. DC fuses should be rated with a sufficient AIC to interrupt the highest possible current.

Air Mass Approximately equal to the secant of the zenith angle--that angle from directly overhead to a line intersecting the sun. The air mass is an indication of the length of the path solar radiation travels through the atmosphere. An air mass of 1.0 means the sun is directly overhead and the radiation travels through one atmosphere (thickness).

Alternating Current (ac) An electric current that reverses direction periodically.

Ambient Temperature The temperature of the surrounding area.

Amorphous Silicon A thin-film PV silicon cell having no crystalline structure. Manufactured by depositing layers of doped silicon on a substrate. See also Single-crystal Silicon & Polycrystalline Silicon.

Ampere (A) Unit of electric current. The rate of flow of electrons in a conductor equal to one coulomb per second.

Ampere-Hour (Ah) The quantity of electrical energy equal to the flow of current of one ampere for one hour. The term is used to quantify the energy stored in a battery.

Angle of Incidence The angle that a light ray striking a surface makes with a line perpendicular to the surface.

Anode The positive electrode in an electrochemical cell (battery). Also, the earth ground in a cathodic protection system. Also, the positive terminal of a diode.

Array A collection of electrically connected photovoltaic (PV) modules.

Array Current The electrical current produced by a PV array when it is exposed to sunlight.

Array Operating Voltage The voltage produced by a PV array when exposed to sunlight and connected to a load.

Availability The quality or condition of a PV system being available to provide power to a load. Usually measured in hours per year. One minus availability equals downtime.

Azimuth Horizontal angle measured clockwise from true north; 180° is true south.

B

Base Load The average amount of electric power that a utility must supply in any period.

Battery A device that converts the chemical energy contained in its active materials directly into electrical energy by means of an electrochemical oxidation-reduction (redox) reaction.

Battery Capacity The total number of ampere-hours that can be withdrawn from a fully charged battery. See Ampere-Hour & Rated Battery Capacity.

Battery Cell The smallest unit or section of a battery that can store electrical energy and is capable of furnishing a current to an external load. For lead-acid batteries the voltage of a cell (fully charged) is about 2.2 volts dc.

Battery Cycle Life The number of times a battery can be discharged and recharged before failing. Battery manufacturers specify Cycle Life as a function of discharge rate and temperature.

Battery Self-Discharge Loss of energy by a battery that is not under load.

Battery State of Charge (SOC) Percentage of full charge or 100 percent minus the depth of discharge. See Depth of Discharge.

Battery Terminology

Captive Electrolyte Battery A battery having an immobilized electrolyte (gelled or absorbed in a material).

Deep-Cycle Battery A battery with large plates that can withstand many discharges to a low SOC.

Lead-Acid Battery A general category that includes batteries with plates made of pure lead, lead-antimony, or lead-calcium immersed in an acid electrolyte.

Liquid Electrolyte Battery A battery containing a liquid solution of acid and water. Distilled water may be added to these batteries to replenish the electrolyte as necessary. Also called a flooded battery because the plates are covered with the electrolyte.

Nickel Cadmium Battery A battery containing nickel and cadmium plates and an alkaline electrolyte.

Sealed Battery A battery with a captive electrolyte and a resealing vent cap, also called a valve-regulated battery. Electrolyte cannot be added.

Shallow-Cycle Battery A battery with small plates that cannot withstand many discharges to a low SOC.

Blocking Diode A diode used to prevent undesired current flow. In a PV array the diode is used to prevent current flow towards a failed module or from the battery to the PV array during periods of darkness or low current production.

British Thermal Unit (Btu) The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit. 1 kw/m2 Ê 317 BTU/ft2 hour

Bypass Diode A diode connected in parallel with a PV module to provide an alternate current path in case of module shading or failure.

C

Capacity (C) The total number of ampere-hours that can be withdrawn from a fully charged battery at a specified discharge rate and temperature. See Battery Capacity.

Cathode The negative electrode in an electrochemical cell. Also, the negative terminal of a diode.

Charge The process of adding electrical energy to a battery.

Charge Controller A device that controls the charging rate and/or state of charge for batteries.

Charge Controller Terminology

Activation Voltage(s) The voltage(s) at which the controller will take action to protect the batteries.

Adjustable Set Point A feature allowing the user to adjust the voltage levels at which the controller will become active.

High Voltage Disconnect The voltage at which the charge controller will disconnect the array from the batteries to prevent overcharging.

High Voltage Disconnect Hysteresis The voltage difference between the high voltage disconnect setpoint and the voltage at which the full PV array current will be reapplied.

Low Voltage Disconnect The voltage at which the charge controller will disconnect the load from the batteries to prevent over-discharging.

Low Voltage Disconnect Hysteresis The voltage difference between the low voltage disconnect setpoint and the voltage at which the load will be reconnected.

Low Voltage Warning A warning buzzer or light that indicates the low battery voltage setpoint has been reached.

Maximum Power Tracking or Peak Power Tracking Operating the array at the peak power point of the array's I-V curve where maximum power is obtained.

Multi-stage Controller Unit that allows different charging currents as the battery nears full SOC.

Reverse Current Protection Any method of preventing unwanted current flow from the battery to the PV array (usually at night). See Blocking Diode.

Series Controller A controller that interrupts the charging current by open-circuiting the PV array. The control element is in series with the PV array and battery.

Shunt Controller A controller that redirects or shunts the charging current away from the battery. The controller requires a large heat sink to dissipate the current from the short-circuited PV array. Most shunt controllers are for smaller systems producing 30 amperes or less.

Single-Stage Controller A unit that redirects all charging current as the battery nears full SOC.

Tare Loss Loss caused by the controller. One minus tare loss, expressed as a percentage, is equal to the controller efficiency.

Temperature Compensation A circuit that adjusts the charge controller activation points depending on battery temperature. This feature is recommended if the battery temperature is expected to vary more than ±5° C from ambient temperature. The temperature coefficient for lead acid batteries is typically -3 to -5 millivolts/° C per cell.

Charge Factor A number representing the time in hours during which a battery can be charged at a constant current without damage to the battery. Usually expressed in relation to the total battery capacity, i.e., C/5 indicates a charge factor of 5 hours. Related to Charge Rate.

Charge Rate The current used to recharge a battery. Normally expressed as a percentage of total battery capacity. For instance, C/5 indicates a charging current equal to one-fifth of the battery's capacity.

Cloud Enhancement The increase in solar intensity caused by reflected irradiance from nearby clouds.

Concentrator A photovoltaic module that uses optical elements to increase the amount of sunlight incident on a PV cell.

Conversion Efficiency The ratio of the electrical energy produced by a photovoltaic cell to the solar energy impinging on the cell.

Converter A unit that converts a dc voltage to another dc voltage.

Crystalline Silicon A type of PV cell made from a single crystal or polycrystalline slice of silicon.

Current (Amperes, Amps, A) The flow of electric charge in a conductor between two points having a difference in potential (voltage).

Cutoff Voltage The voltage levels (activation) at which the charge controller disconnects the array from the battery or the load from the battery.

Cycle The discharge and subsequent charge of a battery.

D

Days of Storage The number of consecutive days the stand-alone system will meet a defined load without solar energy input. This term is related to system availability.

Deep Cycle Type of battery that can be discharged to a large fraction of capacity many times without damaging the battery.

Design Month The month having the combination of insolation and load that requires the maximum energy from the array.

Depth of Discharge (DOD) The percent of the rated battery capacity that has been withdrawn. See Battery State of Discharge.

Diffuse Radiation Radiation received from the sun after reflection and scattering by the atmosphere and ground.

Diode Electronic component that allows current flow in one direction only. See Blocking Diode & Bypass Diode.

Direct Beam Radiation Radiation received by direct solar rays. Measured by a pyrheliometer with a solar aperture of 5.7° to transcribe the solar disc.

Direct Current (dc) Electric current flowing in only one direction.

Discharge The withdrawal of electrical energy from a battery.

Discharge Factor A number equivalent to the time in hours during which a battery is discharged at constant current usually expressed as a percentage of the total battery capacity, i.e., C/5 indicates a discharge factor of 5 hours. Related to Discharge Rate.

Discharge Rate The current that is withdrawn from a battery over time. Expressed as a percentage of battery capacity. For instance, a C/5

discharge rate indicates a current equal to one-fifth of the rated capacity of the battery.

Disconnect Switch gear used to connect or disconnect components in a PV system.

Downtime Time when the PV system cannot provide power for the load. Usually expressed in hours per year or that percentage.

Dry Cell A cell (battery) with a captive electrolyte. A primary battery that cannot be recharged.

Duty Cycle The ratio of active time to total time. Used to describe the operating regime of appliances or loads in PV systems.

Duty Rating The amount of time an inverter (power conditioning unit) can produce at full rated power.

E

Efficiency The ratio of output power (or energy) to input power (or energy). Expressed in percent.

Electrolyte The medium that provides the ion transport mechanism between the positive and negative electrodes of a battery.

Energy Density The ratio of the energy available from a battery to its volume (wh/m3) or weight (wh/kg).

Equalization Charge The process of mixing the electrolyte in batteries by periodically overcharging the batteries for a short time.

F

Fill Factor For an I-V curve, the ratio of the maximum power to the product of the open-circuit voltage and the short-circuit current. Fill factor is a measure of the "squareness" of the I-V curve.

Fixed Tilt Array A PV array set in at a fixed angle with respect to horizontal.

Flat-Plate Array A PV array that consists of non-concentrating PV modules.

Float Charge A charge current to a battery that is equal to or slightly greater than the self discharge rate.

Frequency The number of repetitions per unit time of a complete waveform, expressed in Hertz (Hz).

G

Gassing Gas by-products, primarily hydrogen, produced when charging a battery. Also, termed out-gassing.

Grid Term used to describe an electrical utility distribution network.

I

Insolation The solar radiation incident on an area over time. Equivalent to energy and usually expressed in kilowatt-hours per square meter. See also Solar Resource.

Inverter (Power Conditioning Unit, PCU, or Power Conditioning System, PCS) In a PV system, an inverter converts dc power from the PV array/battery to ac power compatible with the utility and ac loads.

Inverter Terminology

Duty Rating This rating is the amount of time the inverter can supply its rated power. Some inverters can operate at their rated power for only a short time without overheating.

Frequency Most loads in the United States require 60 Hz. High-quality equipment requires precise frequency regulation--variations can cause poor performance of clocks and electronic timers.

Frequency Regulation This indicates the variability in the output frequency. Some loads will switch off or not operate properly if frequency variations exceed 1 percent.

Harmonic Content The number of frequencies in the output waveform in addition to the primary frequency. (50 or 60 Hz.) Energy in these harmonic frequencies is lost and may cause excessive heating of the load.

Input Voltage This is determined by the total power required by the ac loads and the voltage of any dc loads. Generally, the larger the load, the higher the inverter input voltage. This keeps the current at levels where switches and other components are readily available.

Modified Sine Wave A waveform that has at least three states (i.e., positive, off, and negative). Has less harmonic content than a square wave.

Modularity The use of multiple inverters connected in parallel to service different loads.

Power Factor The cosine of the angle between the current and voltage waveforms produced by the inverter. For resistive loads, the power factor will be 1.0.

Power Conversion Efficiency The ratio of output power to input power of the inverter.

Rated Power Rated power of the inverter. However, some units can not produce rated power continuously. See duty rating.

Root Mean Square (RMS) The square root of the average square of the instantaneous values of an ac output. For a sine wave the RMS value is 0.707 times the peak value. The equivalent value of ac current, I, that will produce the same heating in a conductor with resistance, R, as a dc current of value I.

Sine Wave A waveform corresponding to a single-frequency periodic oscillation that can be mathematically represented as a function of amplitude versus angle in which the value of the curve at any point is equal to the sine of that angle.

Square Wave A wave form that has only two states, (i.e., positive or negative). A square wave contains a large number of harmonics.

Surge Capacity The maximum power, usually 3-5 times the rated power, that can be provided over a short time.

Standby Current This is the amount of current (power) used by the inverter when no load is active (lost power). The efficiency of the inverter is lowest when the load demand is low.

Voltage Regulation This indicates the variability in the output voltage. Some loads will not tolerate voltage variations greater than a few percent.

Voltage Protection Many inverters have sensing circuits that will disconnect the unit from the battery if input voltage limits are exceeded.

Irradiance The solar power incident on a surface. Usually expressed in kilowatts per square meter. Irradiance multiplied by time equals Insolation.

I-V Curve The plot of the current versus voltage characteristics of a photovoltaic cell, module, or array. Three important points on the I-V curve are the open-circuit voltage, short-circuit current, and peak power operating point.

J

Joule (J) Unit of energy equal to 1/3600 kilowatt-hours.

K

Kilowatt (kw) One thousand watts. A unit of power.

Kilowatt Hour (kwh) One thousand watt-hours. A unit of energy. Power multiplied by time equals energy.

L

Life The period during which a system is capable of operating above a specified performance level.

Life-Cycle Cost The estimated cost of owning and operating a system for the period of its useful life. See Economics section for definition of terms.

Load The amount of electric power used by any electrical unit or appliance at any given time.

Load Circuit The wire, switches, fuses, etc. that connect the load to the power source.

Load Current (A) The current required by the electrical device.

Load Resistance The resistance presented by the load. See Resistance.

Langley (L) Unit of solar irradiance. One gram calorie per square centimeter. 1 L = 85.93 kwh/m2.

Low Voltage Cutoff (LVC) The voltage level at which a controller will disconnect the load from the battery.

M

Maintenance-Free Battery A sealed battery to which water cannot be added to maintain electrolyte level.

Maximum Power Point or Peak Power Point That point on an I-V curve that represents the largest area rectangle that can be drawn under the curve. Operating a PV array at that voltage will produce maximum power.

Module The smallest replaceable unit in a PV array. An integral, encapsulated unit containing a number of PV cells.

Modularity The concept of using identical complete units to produce a large system.

Module Derate Factor A factor that lowers the module current to account for field operating conditions such as dirt accumulation on the module.

Movistor Metal Oxide Varistor. Used to protect electronic circuits from surge currents such as produced by lightning.

N

NEC An abbreviation for the National Electrical Code which contains guidelines for all types of electrical installations. The 1984 and later editions of the NEC contain Article 690, "Solar Photovoltaic Systems" which should be followed when installing a PV system.

NEMA National Electrical Manufacturers Association. This organization sets standards for some non-electronic products like junction boxes.

Normal Operating Cell Temperature (NOCT) The estimated temperature of a PV module when operating under 800 w/m2 irradiance, 20° C ambient temperature and wind speed of 1 meter per second. NOCT is used to estimate the nominal operating temperature of a module in its working environment.

Nominal Voltage A reference voltage used to describe batteries, modules, or systems (i.e., a 12-volt or 24-volt battery, module, or system).

N-Type Silicon Silicon material that has been doped with a material that has more electrons in its atomic structure than does silicon.

O

Ohm The unit of electrical resistance in which an electromotive force of one volt maintains a current of one ampere.

Open Circuit Voltage The maximum voltage produced by an illuminated photovoltaic cell, module, or array with no load connected. This value will increase as the temperature of the PV material decreases.

Operating Point The current and voltage that a module or array produces when connected to a load. The operating point is dependent on the load or the batteries connected to the output terminals of the array.

Orientation Placement with respect to the cardinal directions, N, S, E, W; azimuth is the measure of orientation from north.

Outgas See Gassing.

Overcharge Forcing current into a fully charged battery. The battery will be damaged if overcharged for a long period.

P

Panel A designation for a number of PV modules assembled in a single mechanical frame.

Parallel Connection Term used to describe the interconnecting of PV modules or batteries in which like terminals are connected together. Increases the current at the same voltage.

Peak Load The maximum load demand on a system.

Peak Power Current Amperes produced by a module or array operating at the voltage of the I-V curve that will produce maximum power from the module. See I-V Curve.

Peak Sun Hours The equivalent number of hours per day when solar irradiance averages 1,000 w/m2. For example, six peak sun hours means that the energy received during total daylight hours equals the energy that would have been received had the irradiance for six hours been 1,000 w/m2.

Peak Watt The amount of power a photovoltaic module will produce at standard test conditions (normally 1,000 w/m2 and 25° cell temperature).

Photovoltaic Cell The treated semiconductor material that converts solar irradiance to electricity.

Photovoltaic System An installation of PV modules and other components designed to produce power from sunlight and meet the power demand for a designated load.

Plates A metal plate, usually lead or lead compound, immersed in the electrolyte in a battery.

Pocket Plate A plate for a battery in which active materials are held in a perforated metal pocket.

Polycrystalline Silicon A material used to make PV cells which consist of many crystals as contrasted with single crystal silicon.

Power (Watts) A basic unit of electricity equal (in dc circuits) to the product of current and voltage.

Power Conditioning System (PCS) See Inverter.

Power Density The ratio of the rated power available from a battery to its volume (watts per liter) or weight (watts per kilogram).

Power Factor The cosine of the phase angle between the voltage and the current waveforms in an ac circuit. Used as a designator for inverter performance. A power factor of 1 indicates current and voltage are in phase and power is equal to the product of volt-amperes. (no reactive power).

Primary Battery A battery whose initial capacity cannot be restored by charging.

Pyranometer An instrument used for measuring global solar irradiance.

Pyrheliometer An instrument used for measuring direct beam solar irradiance. Uses an aperture of 5.7° to transcribe the solar disc.

R

Rated Battery Capacity The term used by battery manufacturers to indicate the maximum amount of energy that can be withdrawn from a battery under specified discharge rate and temperature. See Battery Capacity.

Rated Module Current (A) The current output of a PV module measured at standard test conditions of 1,000 w/m2 and 25° C cell temperature.

Reactive Power The sine of the phase angle between the current and voltage waveforms in an ac system. See power factor.

Remote Site A site not serviced by an electrical utility grid.

Resistance (R) The property of a conductor which opposes the flow of an electric current resulting in the generation of heat in the conducting material. The measure of the resistance of a given conductor is the electromotive force needed for a unit current flow. The unit of resistance is ohms.

S

Sacrificial Anode A piece of metal buried near a structure that is to be protected from corrosion. The metal of the sacrificial anode is intended to corrode and reduce the corrosion of the protected structure.

Seasonal Depth of Discharge An adjustment factor used in some system sizing procedures which "allows" the battery to be gradually discharged over a 30-90 day period of poor solar insolation. This factor results in a slightly smaller PV array.

Secondary Battery A battery that can be recharged.

Self-Discharge The loss of useful capacity of a battery due to internal chemical action.

Semiconductor A material that has a limited capacity for conducting electricity. The silicon used to make PV cells is a semiconductor.

Series Connection Connecting the positive of one module to the negative of the next module. This connection of PV modules or batteries increases the voltage while the current remains the same.

Shallow Cycle Battery A type of battery that should not be discharged more than 25 percent.

Shelf Life The period of time that a device can be stored and still retain a specified performance.

Short Circuit Current (Isc) The current produced by an illuminated PV cell, module, or array when its output terminals are shorted.

Silicon A semiconductor material used to make photovoltaic cells.

Single-Crystal Silicon Material with a single crystalline formation. Many PV cells are made from single crystal silicon.

Solar Cell See Photovoltaic Cell.

Solar Insolation See Insolation.

Solar Irradiance See Irradiance.

Solar Noon The midpoint of time between sunup and sunset. The point when the sun reaches its highest point in its daily traversal of the sky.

Solar Resource The amount of solar insolation a site receives, usually measured in kwh/m2/day which is equivalent to the number of peak sun hours. See Insolation and Peak Sun Hours.

Specific Gravity The ratio of the weight of the solution to the weight of an equal volume of water at a specified temperature. Used as an indicator of battery state of charge.

Stand-Alone PV System A photovoltaic system that operates independent of the utility grid.

Starved Electrolyte Cell A battery containing little or no free fluid electrolyte.

State of Charge (SOC) The instantaneous capacity of a battery expressed at a percentage of rated capacity.

Stratification A condition that occurs when the acid concentration varies from top to bottom in the battery electrolyte. Periodic, controlled charging at voltages that produce gassing will mix the electrolyte. See Equalization.

String A number of modules or panels interconnected electrically in series to produce the operating voltage required by the load.

Subsystem Any one of several components in a PV system (i.e., array, controller, batteries, inverter, load).

Sulfating The normal result of battery discharge when lead-sulfate forms on the surface and in the pores of the active plate material
Sulfation becomes a problem when large crystals of lead sulfate form on the active material as a result of inadequate charging and battery neglect or misuse. The large sulfate crystals are difficult to decompose under charge and return sulfates back to the electrolyte. This effectively reduces
battery capacity and life. Large sulfate crystals may be detectable by a hard rough surface on the active plate material or a low specific gravity after an equalization charge. This is called excessive sulfation or "hard" sulfation.

Surge Capacity The ability of an inverter or generator to deliver high currents momentarily required when starting motors.

System Availability The percentage of time (usually expressed in hours per year) when a PV system will be able to fully meet the load demand.

System Operating Voltage The array output voltage under load. The system operating voltage is dependent on the load or batteries connected to the output terminals.

System Storage See Battery Capacity.

T

TC, TW, THHN See Wire Types

Temperature Compensation An allowance made in charge controllers set points for battery temperatures. Feature recommended when battery temperatures are expected to exceed ±5° C from ambient.

Temperature Factors It is common for three elements in PV system sizing to have distinct temperature corrections. A factor used to decrease battery capacity at cold temperatures. A factor used to decrease PV module voltage at high temperatures. A factor used to decrease the current carrying capability of wire at high temperatures.

Thin Film PV Module A PV module constructed with sequential layers of thin film semiconductor materials. See Amorphous Silicon.

Tilt Angle The angle of inclination of a solar collector measured from the horizontal.

Total ac Load Demand The sum of the ac loads. This value is important when selecting an inverter.

Tracking Array A PV array that follows the path of the sun. This can mean one-axis, east to west daily tracking, or two-axis tracking where the array follows the sun in azimuth and elevation.

Trickle Charge A small charge current intended to maintain a battery in a fully charged condition.

U

UF, USE See Wire Types

Uninterruptible Power Supply (UPS) The designation of a power supply providing continuous uninterruptible service. The UPS will contain batteries.

V

Varistor A voltage-dependent variable resistor. Normally used to protect sensitive equipment from power spikes or lightning strikes by shunting the energy to ground.

Vented Cell A battery designed with a vent mechanism to expel gases generated during charging.

Volt (V) The unit of electromotive force that will force a current of one ampere through a resistance of one ohm.

W

Watt (W) The unit of electrical power. The power developed when a current of one ampere flows through a potential difference of one volt; 1/746 of a horsepower.

Watt Hour (Wh) A unit of energy equal to one watt of power connected for one hour.

Waveform The characteristic shape of an ac current or voltage output.

Water Pumping Terminology

Centrifugal Pump See rotating pump

Displacement or Volumetric Pump A type of water pump that utilizes a piston, cylinder and stop valves to move packets of water.

Dynamic Head The vertical distance from the center of the pump to the point of free discharge of the water. Pipe friction is included. See Friction Head.

Friction Head The energy that must be overcome by the pump to offset the friction losses of the water moving through a pipe.

Rotating Pump A water pump using a rotating element or screw to move water. The faster the rotation, the greater the flow.

Static Head The vertical distance from the water level to the point of free discharge of the water. It is measured when the pump is not operating.

Storage This term has dual meaning for water pumping systems. Storage can be achieved by pumping water to a storage tank, or storing energy in a battery subsystem.

Suction Head The vertical distance from the surface of the water source to the center of the pump (when the pump is located above the water level).

Wet Shelf Life The period of time that a charged battery, when filled with electrolyte, can remain unused before dropping below a specified level of performance.

Wire Types See Article 300 of National Electric Code for more information

Tray Cable (TC) - may be used for interconnecting balance-of-systems (BOS).

Underground Feeder (UF) - may be used for array wiring if sunlight resistant coating is specified; can be used for interconnecting BOS components but not recommended for use within battery enclosures.

Underground Service Entrance (USE) - may be used within battery enclosures and for interconnecting BOS.

TW/THHN - may be used for interconnecting BOS but must be installed in conduit--either buried or above ground. It is resistant to moisture.

Z

Zenith Angle The angle between directly overhead and the line intersecting the sun. (90° - zenith) is the elevation angle of the sun above the horizon.