

A glossary of renewable energy

All those technical terms can make renewable energy systems difficult for many people to understand. This glossary aims to cover all of the most commonly used terms, as well as a few of the more specific terms.

A

Alternating Current (AC): Electrical *current* that continually reverses direction. The frequency at which it reverses is measured in cycles-per-second, or *Hertz* (Hz). The magnitude of the current itself is measured in *amps* (A). Mains electricity is AC electricity.

Alternator: A device for producing AC *electricity*. Usually driven by a motor, but can also be driven by other means, including water and wind power.

Ammeter: An electrical or electronic device used to measure *current* flowing in a circuit.

Amorphous silicon: A non-crystalline form of *silicon* used to make *photovoltaic panels*.

Ampere (Amp): The unit of measurement of electrical *current*. Symbol is A or I.

Ampere-hour, Amp-hour (AH): A measurement of electrical *current* over time. One amp-hour is equivalent to one *amp* of current flowing for one hour.

Anode: The positive *electrode* in a *battery*, *diode* or other electrical device.

Anemometer: A device used to measure wind speed.

Axial flow turbine: a turbine in which the flow of water is in the same direction as the axis of the turbine.

B

Battery: A device, made up of a collection of *cells*, used for storing *electricity*. Can be either *rechargeable* or non-rechargeable. Batteries types include *flooded cell*, *sealed*, and *dry cell*. Battery chemistries include lead-acid, nickel-metal-hydride (NiMH), nickel-cadmium (NiCad) and Lithium.

Battery charger: A device used to charge a *battery* by converting (usually) mains voltage AC to a DC voltage suitable for the battery. Chargers often incorporate some form of *regulator* to prevent over-charging and damage to the battery. Available in both *switchmode* and *ferro-magnetic* types.

Betz Limit: The maximum power (theoretically) that can be captured by a wind turbine from the wind. Equal to 59.3 percent of the wind energy.

Blade: The part of a turbine that water or air reacts against to cause the turbine to spin. Sometimes incorrectly referred to as the propeller. Most electricity-producing wind turbines will have two or three blades, whereas water-pumping wind turbines will usually have up to 20 or more.

C

Cathode: The negative *electrode* in a *battery*, *diode* or other electrical device.

Capacitor: An electronic component used for the temporary storage of *electricity*, as well for removing unwanted *noise* in circuits. A capacitor will block DC but will pass AC. New high capacity types called ultracapacitors are now being used as battery replacements in hybrid vehicles and small renewable energy systems.

Cell: The most basic, self-contained unit that contains the appropriate materials, such as *plates* and *electrolyte*, to produce *electricity*.

CIGS (or CIS): Copper indium [gallium] selenide. A type of semiconducting material used to make high efficiency thin film *photovoltaic cells*.

Circuit breaker: An electrical device used to interrupt an electrical supply in the event of excess *current* flow. Can be either magnetically or thermally activated, or a combination of both. Can be manually or automatically reset.

Conductor: A material used to transfer, or conduct, *electricity*, often in the form of wires.

Cold cathode fluorescent lamp (CCFL): A type of compact fluorescent lamp that uses a tube that does not contain heating elements at each end. CCFLs can take several minutes to warm up, but their tubes can be much smaller than a regular CFL.

Compact fluorescent lamp (CFL): A form of *fluorescent lighting* that has its tube 'folded' into a 'U' or other more compact shape, so as to reduce the space required for the tube.

Conduit: A pipe or elongated box used to house and protect electrical cables.

Converter: An electronic device that converts *electricity* from one DC voltage level to another.

Cross-flow turbine: A turbine where the flow of water is at right angles to the axis of rotation of the turbine.

Current: The rate at which electricity flows in a *conductor*. Analogous to the volume of water flowing through a pipe. Measured in *Amperes*, or Amps.

D

Darrius Rotor: A form of *vertical-axis wind turbine* that uses thin *blades*.

Direct Current (DC): Electrical *current* that flows in one direction only, although it may vary in magnitude. Batteries produce DC electricity.

Diode: A *semi-conductor* device that allows *current* to flow in one direction, while blocking it in the other. Also see *Light emitting diode*.

Dry cell battery: A *battery* that uses a solid paste for an *electrolyte*. Common usage refers to small cylindrical 'torch' *cells*. Not usually rechargeable.

E

Earth: Refers to physically connecting a part of an electrical system to the ground, done as a safety measure, by means of a conductor embedded in suitable soil.

Earth-leakage Circuit Breaker (ELCB): A device used to prevent electrical shock hazards in mains voltage power systems, including *independant power systems*. Also known as residual current devices (RCDs).

Electric vehicle: A vehicle that uses rechargeable batteries and an electric motor and controller for motive power instead of an internal combustion engine. Slowly becoming more common as manufacturers look for low emission vehicle solutions.

Electricity: The movement of electrons (a sub-atomic particle), produced by a *voltage*, through a *conductor*.

Electrode: An electrically *conductive* material, forming part of an electrical device, often used to lead current into or out of a liquid or gas. In a battery, the electrodes are also known as *plates*.

Electrolysis: A chemical reaction caused by the passage of *electricity* from one *electrode* to another.

Electrolyte: The connecting medium, often a fluid, that allows electrolysis to occur. All common batteries contain an electrolyte, such as the sulphuric acid used in *lead-acid batteries*.

Energy: Power consumed multiplied by the duration of use. For example, 500 *watts* used for four hours is 2000 *watt-hours*. Also commonly expressed as kilowatt-hours, where one kilowatt-hour is 1000 watt-hours.

Equalising charge: Charging of a lead acid battery so that the electrolyte starts to bubble. This ensures that the electrolyte is the same density throughout each cell and that all cells reach a fully charged state.

F

Float charge: A way of charging a battery by varying the charging *current*, so that its terminal *voltage* (the voltage measured directly across its terminals) 'floats' at a specific voltage level.

Flooded cell battery: A form of *rechargeable battery* where the *plates* are completely immersed in a liquid *electrolyte*. The starter battery in most cars is of the flooded-cell type. Flooded cell batteries are the most commonly used type for independant and remote area power supplies.

Fluorescent light: A form of lighting that uses long thin tubes of glass which contain mercury vapour and various phosphor powders (chemicals based

on phosphorus) to produce white light. See also *Compact fluorescent lamp*.

Furling: A method of preventing damage to *horizontal-axis wind turbines* by automatically turning them out of the wind using a spring-loaded tail or other device.

Fuse: An electrical device used to interrupt an electrical supply in the event of excess current flow. Often consists of a wire, encased in a glass tube for safety, that melts when excess current flows through it.

G

Gell-cell battery: A form of *lead-acid battery* where the *electrolyte* is in the form of a gell or paste. Usually used for mobile installations and when batteries will be subject to high levels of shock or vibration.

Generator: A mechanical device used to produce *DC electricity*. Power is produced by coils of wire passing through magnetic fields inside the generator. See also *Alternator*. Most *alternating current* generating sets are also referred to as *generators*.

Gigawatt (GW): A measurement of *power* equal to a thousand million *watts*.

Gigawatt-hour (GWhr): A measurement of energy. One gigawatt-hour is equal to one *gigawatt* being used for a period of one hour, or one *megawatt* being used for 1000 hours.

H

Halogen lamp: A special type of *incandescent* globe made of quartz glass and a tungsten filament, enabling it to run at a much higher temperature than a conventional incandescent globe. Efficiency is better than a normal incandescent, but not as good as a *fluorescent* light. Most commonly found in downlights. Sometimes called a dichroic lamp, in reference to the reflector coating used on some halogen reflector lamps, that allows heat (infra-red) to exit the rear of the lamp while visible light is reflected forward.

Head: The vertical distance that water will fall from the inlet of the collection pipe to the water turbine in a hydro power system. Only the vertical component is measured, not the entire length of pipe.

Hertz (Hz): Unit of measurement for frequency, equal to cycles per second—see *AC (Alternating Current)*. Common household mains power is normally 50Hz, or 50 cycles per second.

Horizontal-axis wind turbine: The most common form of *wind turbine*, consisting of two or three (but up to six or more in some designs) airfoil-style blades attached to a central hub which drives a *generator*. The axis, or main shaft of the machine is horizontal, or parallel to the earth's surface.

I

Incandescent globe: One of the most common forms of light globe in the home, usually consisting of a glass globe inside which is a wire filament that glows when *electricity* is passed through it. They are the least efficient of all electrical lighting systems, and certain types are now being phased out in numerous countries, including Australia.

Independant power supply system: A power generation system that is independant of the mains grid.

Insolation: The level of intensity of energy from the sun that strikes the earth. Usually given as watts per square metre (W/m^2). A common level in Australia in summer is about $1000W/m^2$.

Insulation: A material used to prevent the flow of electricity. Normally used on electrical wires to prevent electric shock. Typical materials used include plastics such as *PVC* and polypropylene, as well as ceramics and minerals such as mica.

Insulation: A material used to prevent the flow of heat into or out of a building. Often consists of 'batts' placed in the ceilings and walls, but can also be metal foil or 'loose fill' materials, such as recycled paper fluff.

Inverter: An electronic device used to convert *DC electricity* into *AC*, usually with an increase in *voltage*. Inverters can have either a *sine wave* or *modified square wave* output. The two main types are stand-alone inverters, which are designed to act as a replacement for mains power, and grid-interactive inverters, which feed energy from various power sources such as solar panels back into the grid. Some inverters can perform both functions.

J

Junction box: An insulating box, usually made from plastics such as *PVC*, used to protect the connection point of two or more cables.

K

Kilowatt (KW): A measurement of power equal to one thousand *watts*.

Kilowatt-hour (KWhr): A measurement of *energy*. One kilowatt-hour is equal to one *kilowatt* being used for a period of one hour.

L

Lead-acid battery: A type of *battery* that consists of *plates* made of lead and lead-oxide, surrounded by a sulphuric acid *electrolyte*. The most common type of battery used in *RAPS* systems.

Light emitting diode (LED): A semiconductor device which produces light of a single or very narrow band of colours, or white light at various colour temperatures. LEDs are used for indicator lights as well as for domestic and commercial lighting. Readily available in red, green, blue, yellow and amber, as well as cool, neutral and warm whites. High quality LEDs have a very long rated life, as much as 100,000 hours. LEDs are set to become the most common source of artificial lighting in the next few years.

Lithium battery: A type of *rechargeable battery* that uses lithium metal or metal compounds. Characterised by high storage densities and long cycle life. Commonly found in portable electronic devices, power tools, and increasingly in *electric vehicles*.

Load: The collective appliances and other devices connected to a power source. When used with a *shunt regulator*, a load is often used to absorb any excess power being generated.

M

Megawatt (MW): A measurement of power equal to one million *watts*.

Megawatt-hour (MWhr): A measurement of power

with respect to time (energy). One megawatt-hour is equal to one *megawatt* being used for a period of one hour, or one *kilowatt* being used for 1000 hours.

Metres-per-second (m/s): A speed measurement system, often used to measure wind speed. 1m/s equals 2.2 miles per hour or 3.6 km/h.

Micro-hydro system: A domestic-scale generation system that uses water to produce *electricity*. Types of *water turbine* include *Pelton*, *Turgo*, *Crossflow*, *Overshot* and *Undershot waterwheels*.

Modified-square-wave: A type of waveform produced by some stand-alone *inverters*. Looks like this: $\square \square \square \square$. This type of waveform is not as suitable for some appliances as a *sine wave*. Some inverters produce a multi-step waveform that manufacturers tend to call modified sine-wave. These are not true sinewave inverters.

Monocrystalline solar cell: A form of solar cell made from a thin slice of a single large crystal of *silicon*. Monocrystalline cells have the highest embodied energy of all the solar cell types.

Multimeter: A type of meter used for testing electrical circuits. A multimeter can usually measure voltage, current and resistance, and some can also measure frequency, capacitance, inductance and other parameters.

N

Nacelle: That part of a *wind generator* that houses the *generator*, gearbox etc at the top of the tower.

Nickel-cadmium battery (nicad): A form of rechargeable battery, having higher *storage densities* than that of lead-acid batteries, that use a mixture of nickel hydroxide and nickel oxide for the *anode* and cadmium metal for the *cathode*. The *electrolyte* is potassium hydroxide. Very common in small rechargeable appliances, but rarely found in *independant power systems* due to their high initial cost.

Nickel-metal-hydride battery (NiMH): A form of rechargeable battery, similar to a nicad, but being made with more benign materials, so without the toxicity of cadmium. Very common in small rechargeable appliances.

Noise: Unwanted electrical signals produced by electric motors and other machines that can cause circuits and appliances to malfunction. Often caused by cheap inverters without adequate filtering.

O

Ohm: The unit of measurement of electrical *resistance*. Symbol is Ω . A resistance of one ohm will allow one *amp* of *current* to pass through it at a *voltage drop* of one *volt*.

Ohm's Law: A simple mathematical formula that allows either *voltage*, *current* or *resistance* to be calculated when the other two values are known. The formula is: $V = I \times R$, where V is the voltage, I is the current, and R is the resistance.

P

Pelton wheel: A *water turbine* in which specially shaped buckets attached to the periphery of a wheel are struck by a jet of water from a narrow nozzle. Only suitable for high head (high pressure) systems.

Photovoltaic effect: The effect that causes a volt-

age to be developed across the junction of two different materials when they are exposed to light.

Photovoltaic cells: Flat cells made from various photovoltaic materials such as silicon, copper-indium-gallium-selenide (CIGS) and Cadmium Telluride (CdTe). Multiple photovoltaic cells are manufactured into large arrays to form photovoltaic panels, usually just called solar panels or PVs.

Pitch: Loosely defined as the angle of the blades of a wind or water turbine with respect to the flow of the wind or water.

Plates: The *electrodes* in a battery. Usually take the form of flat metal plates, but may be many shapes, including cylindrical. The plates usually participate in the chemical reaction of a battery, but sometimes just provide a surface for the migration of electrons through the *electrolyte*.

Polycrystalline silicon: *Silicon* used to manufacture *photovoltaic panels* which is made up of multiple crystals clumped together to form a solid mass. Manufactured by casting molten silicon into ingots.

Power: The rate of doing work. Expressed as watts (W). For example, a *generator* rated at 800 watts can provide that amount of power continuously.

PVC (Poly-vinyl chloride): A plastic used as an insulator on electrical cables, as well as for *conduits*. Contains toxic chemicals such as plasticisers. Unplasticised PVC (U-PVC) is less hazardous as it doesn't contain plasticisers such as phthalates which are often considered carcinogenic, but it does still require toxic chlorine compounds to make.

R

Rechargeable battery: A type of *battery* that uses a reversible chemical reaction to produce *electricity*, allowing it to be reused many times. The chemical reaction is reversed by forcing *electricity* through the battery in the opposite direction to normal discharge.

Regulator: A device used to limit the *current* and *voltage* in a renewable energy system, normally to allow the correct charging of *batteries* from power sources such as *solar panels* and *wind generators*. Also refers to a type of electronic component used in electronic circuits to provide regulated voltage to voltage sensitive devices.

RAPS (Remote Area Power Supply): A power generation system used to provide electricity to remote and rural homes, usually generating power from *renewable* sources such as *solar panels* and *wind generators*, as well as non-renewable sources such as petrol-powered generators. A RAPS is a form of *independent power supply system*.

Renewable energy: Energy that is produced from a renewable source, such as sunlight, flows of wind or water, or sustainably grown plants.

Residual Current Device (RCD): See *earth-leakage circuit breaker*.

Resistance: A material's ability to restrict the flow of electrical *current* through itself. Measured in *Ohms*.

Resistor: An electronic component used to restrict the flow of *current* in a circuit. Sometimes used specifically to produce heat, such as in a heating element. Often used with LEDs to control the current through them to a safe level.

Rotor: that part of a *wind turbine* that consists of the

blades attached to the hub.


S

Savonius rotor: A type of *vertical axis wind turbine* that uses half-drum shaped '*blades*' to catch the wind and turn a shaft. Generally a low speed turbine with high torque, usually used for water pumping but sometimes for *electricity* generation.

Sealed lead-acid battery: A form of *lead-acid battery* where the *electrolyte* is immobilised, by either being contained in an absorbent fibre separator or gell between the batteries *plates*. The battery is sealed so that no electrolyte can escape, and thus can be used in any position, even inverted with some models.

Semi-conductor: A material that only partially conducts *electricity*. Neither an insulator nor a true conductor. *Transistors* and other electronic devices are made from semi-conducting materials and are often called semi-conductors.

Shunt: A low-value *resistance*, connected in *series* with a *conductor*, that allows measurements of *currents* flowing in the conductor by measurement of *voltage* across the shunt. Often used with devices such as *inverters* to allow monitoring of the energy used.

Sine wave: A sinusoidal-shaped electrical waveform. Mains power is a sine wave, as is the power produced by some inverters. The shape of a sinusoidal wave looks like this: . The sine wave is the most ideal form of electricity for running more sensitive appliances, such as radios, TVs, computers and the like.

Solar cell: A single *photovoltaic* device, usually made of *silicon*, that converts light into electricity.

Solar panel: A device used to convert light from the sun directly into *DC electricity* by using the *photovoltaic effect*. Usually made of multiple *solar cells* bonded between glass and a backing material. Also called a *photovoltaic panel*.

Solar power: *Electricity* generated by conversion of sunlight, either directly through the use of *photovoltaic panels*, or indirectly through *solar-thermal* processes.

Solar Thermal: A form of power generation using sunlight to heat water or other fluid that is then used to drive a motor or turbine, or to use the heated water directly, such as in a solar hot water system.

Storage density: The capacity of a battery, in *amp-hours*, compared to its weight or volume. Measured in *watt-hours* per kilogram or *watt-hours* per litre.

Surge: An unexpected flow of excessive *current*, usually caused by excessive *voltage*, that can damage appliances and other electrical equipment.

Surge: An excessive amount of power drawn by an appliance when it is first switched on. Inverters usually have a surge rating, which is the maximum surge current or power they can produce for a short period.

Switchmode: A form of converting one form of electricity to another by rapidly switching it on and off and feeding it through a *transformer* to effect a *voltage* change. Many power supplies are switchmode devices and are typically more efficient, smaller and lighter than older style ferro-magnetic supplies.

T

Tip-speed ratio: The ratio of *blade* tip speed to wind speed for a *wind turbine*.

Transistor: A *semi-conductor* device used to switch or otherwise control the flow of *electricity*.

Transformer: A device consisting of two or more insulated coils of wire wound around a magnetic material such as iron, used to convert one *AC voltage* to another or to electrically isolate individual circuits.

Turbulence: Airflow that varies in speed and direction rapidly and often that can cause damage to *wind turbines*. Often caused by objects such as trees or buildings.

V

Vertical-axis wind turbine: A *wind turbine* with the axis or main shaft mounted vertically, or perpendicular to the earth's surface. This type of turbine does not have to be turned to face the wind—it always does. Types include Savonius and Darrius.

Voltage: Unit of measurement for the electrical 'pressure' of *electricity*. Measured in volts (V).

Voltage drop: The *voltage* lost along a length of wire or *conductor* due to the *resistance* of that conductor. This also applies to *resistors*. The voltage drop is calculated by using *Ohm's Law*.

Voltmeter: An electrical or electronic device used to measure *voltage*.

W

Water turbine: A device that converts the motion of the flow of water into rotational motion. Often used to drive *generators* or pumps. See *micro-hydro system*.

Waterwheel: A simple water turbine, often consisting of a series of paddles or boards attached to a central wheel or hub, that is connected to a *generator* to produce *electricity* or a pump to move water.

Watt (W): A measurement of power, commonly used to define the rate at which an appliance consumes energy.

Watt-hour (Whr): A measurement of power with respect to time (energy). One watt-hour is equal to one *watt* being used for a period of one hour.

Wind farm: A group of *wind generators* that usually feeds power into the mains grid.

Wind generator: A mechanical device used to produce *electricity* from the wind. Typically a form of *wind turbine* connected to a *generator*. *

Wind turbine: A device that converts the motion of the wind into rotational motion. Often used to drive *generators* or pumps. *

* Wind generator, wind turbine and windmill are commonly used interchangeably to describe complete wind-powered electricity generating machines.

Y

Yaw: The orientation of a *horizontal-axis wind turbine*.

Z

Zener diode: A *diode* often used for *voltage* regulation or protection of other components.