PV-Vocabulary

3D-Solar Cell: capture photons from sunlight using an array of miniature "tower" structures that resemble high-rise buildings in a city street grid. Animation on: www.gatech.edu/news-room/flash/CNTpv.html

Amp: short for ampere, the unit used to measure the instantaneous flow of electrons, theoretically, $6.02x10^{23}$ electrons.

Amp-hour: measure of a batteries ability to sustain a flow of energy over time; 60 amp-hours indicated a battery can deliver one amp for sixty hours.

Balance of System (components): the complete system minus the modules.

Base-load electricity: the smallest amount of electricity consumed by a utility's customers. Base load is provided by slow-to-start, relatively inexpensive-to-operate generators, while peak-load is provided by quickly dispatchable sources.

Biodegradation: is the decomposition of organic material by microorganisms. The term is often used in relation to sewage treatment, environmental remediation (bioremediation) and to plastic materials.

Charge controller: the device in a stand-alone energy system that feeds electricity from the source, typically a PV array, to the battery bank. The charge controller protects the batteries from overcharging.

Clean energies: *Clean* describes any energy source the exploitation of which does not generate significant amounts of pollution, and therefore negatively impact the health of human populations and the biosphere as a whole.

Current: flow. In a river, the current is usually strongest near the center where the river is deepest. In electrical terms, current means the electrons flowing through a conductor, and is measured in amperes, one amp meaning 6.02x1023 electrons.

Distributed energies: *Distributed* describes any energy source that can be deployed – often rapidly - on small, medium or large scales close to the point of consumption.

Distributed generation *(DG):* contrasts with *centralized generation*, a term that characterizes conventional large-scale fossil fuel or nuclear power plant generation.

Doping: Semiconductors into which tiny quantities of impurities (boron, phosphorus) have been deliberately diffused. This process dramatically alters the behavior of the semiconductor in a very useful manner.

Efficiencies of a PV cell/module/system: the ratio of the maximum electric power and the power of the incident light. The amount of solar energy that strikes the Earth's surface is the equivalent of about 1 kW per square meter. This works out to 1 kiloWatt per hour (kWh) worth of sunlight per hour. A PV-system with an overall conversion efficiency of 10% would produce 0.1 kWh of electricity per hour.
Usually efficiencies are determined under standard test conditions of 1,000 W/m2 illumination and 25°C. The spectral distribution of the light is expressed in terms of an optical air mass (AM) number. AM0 corresponds to the spectrum in space, AM1 to the spectrum at the earth's surface when the sun is overhead, AM2 when the sun is 60° off overhead, etc. (idealized cases). Cells and modules for terrestrial use are generally measured under AM1 or AM1.5 conditions. (see also *peak watts* (Wp)

Electrolysis: a chemical process in which the hydrogen and oxygen atoms in water are separated by the application of electricity.

Electrolyte: "battery juice"; in lead-acid batteries, more-or-less dilute sulfuric acid. Consumer batteries use a solid electrolyte made up of filler impregnated with chemicals. The electrolyte allows ions to migrate to the battery's anode and cathode and react, producing a flow of electricity.

Energy Payback Time: the time required to produce an amount of energy that is equal to the amount of energy consumed during the fabrication (of the device).

Energy Return on Investment: is the ratio of electricity generated, divided by the energy required to build and maintain the equipment.

External Costs (aka Externality)**:** arises when the social or economic activities of one group of persons have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group. Thus, a power station that generates emissions of SO2, causing damage to building materials or human health, imposes an external cost. This is because the impact on the owners of the buildings or on those who suffer damage to their health is not taken into account by the generator of the electricity when deciding on the activities causing the damage. In this example, the environmental costs are "external" because, although they are real costs to these members of society, the owner of the power station is not taking them into account when making decisions. Note that external costs are unintended and result from there being no property rights or markets for these environmental effects. The potential value of the Externality project therefore lies in valuing external costs in order for those values to be included in the design of policy to correct for the present lack of such property rights and markets.

Field Assisted Simultaneous Synthesis and Transfer (FASST): A patented nanotechnology printing process (Heliovolt) which allows PV cells to be printed directly on metal, glass and other building materials.

Fill factor: Another defining term in the overall behavior of a solar cell is the fill factor (FF). This is the ratio of the *maximum power point* divided by the *open circuit voltage* (V_{oc}) and the *short circuit current* (I_{sc}).

Fuel cell: is an electrochemical device similar to a battery, but differing from the latter in that it is designed for continuous replenishment of the reactants consumed; i.e. it produces electricity from an external fuel supply of hydrogen and oxygen as opposed to the limited internal energy storage capacity of a battery.

Grid-excited inverter: an inverter changes DC electricity -- the kind that comes out of PVs -- into AC or house current. A grid-excited inverter, which is connected to the power grid and exports locally-harvested electricity into it, only operates when the grid is energized.

Inverter: a device that converts DC electricity, as produced by PVs and stored in batteries, into AC house current, the kind used by most familiar household devices.

KW: - kiloWatt. 1 kiloWatt= 1000 Watt **– Unit of power. 1000 kW= 1 megaWatt (mW), 1000 megaWatt = 1 gigaWatt, 1000 gigaWatt = 1 teraWatt.**

kWh – kiloWatt hour: labour done by letting work 1000 Watt during 1 hour.

Lead-acid batteries: the commonest and most cost-effective form of storage batteries, found in vehicles, uninterruptible power supplies, and renewable energie powered home systems.

Load: in electricity, any device that consumes electricity, so an electric water heater is a big load, and a clock or a night light is a little load.

Low-voltage: in electrical terms, less than house current, typically 12 or 24 volts.

Lumens: an exact measure of quantity of light. A 60-watt incandescent light bulb and an 18-watt compact fluorescent light bulb each produce about 1,000 lumen.

1 megawatt peak of PV-modules: **is the amount that delivers 1 MW of electric** power under standard illumination conditions (1,000 W/m2, 25 or 28 C)).

MPP- tracking - Maximum Power Point Tracking: - a transformer has to deliver the max. power at all possible light circumstances which goes with a certain voltage delivered by the panel. This voltage depends on the amount of light falling on the panel. Power is the product of

voltage and current and hence at a given voltage there is a specific current. At every voltage there is an optimal current (maximum power point). In the inverter the electronic parts look under every circumstances this optimal point: MPP-tracking

Mono-Crystalline Silicon Cells: high-grade, single-crystal, high-efficiency PV cells sliced from a single crystalline boule of purified silicon

Multicrystalline (polycrystalline) Silicon Cells: many crystals of silicon in a semi-chaotic state, typical of medium-grade, medium-efficiency photovoltaic material.

Ohm's Law: the mathematical product of current and voltage, P=IV.

Open-circuit voltage (Voc): is the voltage across the positive and negative terminals under open-circuit conditions, and the current is zero, which corresponds to a load resistance of infinity. (See *Short-circuit current (Isc)*)

Organic Photovoltaic (OPV): refers to polymers that are capable of generating electrical power from light.

Over-voltage: a circumstance in which the voltage is too high -- sun shining on a PV array on a cold day with snow on the ground might produce more voltage than a charge controller can handle, and so the over-voltage protection cuts the connection.

Passive Solar: The natural power of solar heat and light. Many buildings are designed to take advantage of this natural resource through the use of passive solar heating and daylighting. The south side of a building always receives the most sunlight. Therefore, buildings designed for passive solar heating usually have large, south-facing windows. Materials that absorb and store the sun's heat can be built into the sunlit floors and walls. The floors and walls will then heat up during the day and slowly release heat at night, when the heat is needed most. This passive solar design feature is called *direct gain*.
Other passive solar heating design:

- ***Sunspace:*** (much like a greenhouse) is built on the south side of a building. As sunlight passes through glass or other glazing, it warms the sun space. Proper ventilation allows the heat to circulate into the building.
- ***Trombe wall:*** is a very thick, south-facing wall, which is painted black and made of a material that absorbs a lot of heat. A pane of glass or plastic glazing, installed a few inches in front of the wall, helps hold in the heat. The wall heats up slowly during the day. Then as it cools gradually during the night, it gives off its heat inside the building.

Peak Watt: is the amount of power produced when the module receives 1,000 watts per square meter of exposure to the sun (insulation). It is used for rating PV-Systems.

Photon: refers to a "packet" of light, but something no one has ever isolated, described, or measured individually in any way. Since the "wave theory" of light is unable to explain the way light travels across the vast vacuum of space, a "particle theory" became necessary. It has proved a useful model, as it also explains the way the photoelectric effect works. Physicists find it very convenient to be able to switch back and forth between models when explaining the way light works. Some day they may find a unifying theory. Meanwhile, light is a wave, or a photon, depending...

Peak oil: is the point in time when the maximum rate of global petroleum production is reached, after which the rate of production enters its terminal decline. If global consumption is not mitigated before the peak, an energy crisis may develop because the availability of conventional oil will drop and prices will rise, perhaps dramatically.

Photovoltaic effect: the generation of a voltage and/or a current by absorption of light in some material or combination of materials.

Photovoltaics: The term photovoltaic is derived by combining the Greek word for light, '*photos*', with '*volt'* the name of the unit of electromotive force, the force that causes the

motion of electrons (I.e. An electrical current). The volt was named after the Italian physicist Count Alessandro Volta, the inventor of the battery. It also refers to the field of research related to solar cells.

Photovoltaic cell (see also Solar cell)**:** is a device that converts light energy into electrical energy by the *photovoltaic effect*. Sometimes the term *solar cell* is reserved for devices intended specifically to capture energy from sunlight, while the term *photovoltaic cell* is used when the source is unspecified.

Quantum Dot: also called a semiconductor nanocrystal, is a semiconductor crystal whose size is on the order of just a few nanometers. At 10 nanometers in diameter, nearly 3 million quantum dots could be lined up end to end and fit within the width of a human thumb. A quantum dot is a semiconductor nanostructure that confines the motion of conduction band electrons, valence band holes, or excitons in all three spatial directions. A quantum dot has a discrete quantized energy spectrum. The corresponding wave functions are spatially localized within the quantum dot, but extend over many periods of the crystal lattice. A quantum dot contains a small integer number (of the order of 1-100) of conduction band electrons, valence band holes, or excitons, i.e., an integer number of elementary electric charges. One of the optical features of small excitonic quantum dots immediately noticeable to the unaided eye is coloration. While the material which makes up a quantum dot defines its intrinsic energy signature, more significant in terms of coloration is the size. The larger the dot, the redder (the more towards the red end of the spectrum) the fluorescence. The smaller the dot, the bluer (the more towards the blue end) it is. The coloration is directly related to the energy levels of the quantum dot.

Quantum efficiency (QE): is the ratio of the number of charge carriers collected by the solar cell to the number of photons — or packets of light — of a given energy shining on the solar cell. This is a term intrinsic to the *light absorbing material*, and not the cell as a whole (which becomes more relevant for *thin-film* solar cells). This term should not be confused with energy conversion efficiency, as it does not convey information about the power collected from the solar cell.

Renewable energies: *Renewable* describes any energy source whose availability or supply will not be permanently depleted as a result of exploitation over a period of time that is meaningful to people. Fossil fuels (coal, oil and natural gas), which formed over millions of years of geological conditioning, are considered *nonrenewable* because their global supply will not be regenerated at a rate that is proportional to current and future uses. By contrast, solar power is in constant supply every day and will be for another several billion years (until the end of the Sun).

Semi-conductor: a non-metallic material such as germanium and silicon, whose electrical characteristics lie between those of conductors, which offer little resistance to the flow of electrical current, and insulators, which block the flow of current almost completely. Hence the term *semi*conductor: electrically conductive under some circumstances, and resistant under others.

Short-circuit current (Isc): is the current produced when the positive and negative terminals of the cell are short-circuited, and the voltage between the terminals is zero, which corresponds to a load resistance of zero. (See *Open-circuit voltage (Voc)*)

Solar cell (see also "Photovoltaic" cell): is a device that converts photons from the sun (solar light) into electricity. In general, a solar cell that includes both solar and nonsolar sources of light (such as photons from incandescent bulbs) is termed a photovoltaic cell.
Fundamentally, the device needs to fulfill only two functions:
1. photogeneration of charge carriers (electrons and holes) in a light-absorbing material, and
2. separation of the charge carriers to a conductive contact that will transmit the electricity.
This conversion is called *the photovoltaic effect.*
Photovoltaics is the field of research related to solar cells. Solar cells have many applications. Historically solar cells have been used in situations where electrical power from the grid is

unavailable, such as in remote area power systems, Earth orbiting satellites, consumer systems, e.g. handheld calculators or wrist watches, remote radio-telephones and water pumping applications. Solar cells are regarded as one of the key technologies towards a sustainable energy supply.

Solar cell's energy conversion efficiency: is the percentage of power converted from absorbed light to electrical energy and then collected when a solar cell is connected to an electrical circuit.
Or:
The efficiency of a solar cell is defined as the percentage of solar energy falling on its surface that is converted into electrical energy.
Under a typical sunny day, a one square meter surface of solar cells exposed to the sun around noontime will receive approximately 1,000 W. When for instance multi silicon cells convert 15% of this into electricity, a one square meter of multi cells will generate 150 electric Watts in full sunshine.

Solar Cycle: The 11-year variation in the Sun's magnetic field and all the features caused by it such as the number of sunspots, coronal mass ejections and solar flares. The variation is seen as an increase and decrease of solar activity on a regular basis, lasting approximately 11 years from beginning of end.

Solar-hydrogen fuel cell energy system: a photovoltaic array produces electricity to provide for the primary electricity load (home), as well as enough excess electricity to run an electrolyzer which converts water into hydrogen. The hydrogen produced will be reserved in a storage tank until needed, at which point it will be converted back into electricity through means of a fuel cell. To increase energy efficiency.
If 1% of the world's desserts were covered in mirrors they would produce enough electricity to power the whole world, with a technology which is pollution free reduces carbon dumping every year.

Solar panels: are devices for capturing the energy in sunlight. The term solar panel can be applied to either solar hot water panels (usually used for providing domestic hot water) or solar photovoltaic panels (providing electricity).

Solar power: describes a number of methods of harnessing energy from the light of the Sun. It has been present in many traditional building methods for centuries, but has become of increasing interest in developed countries as the environmental costs and limited supply of other power sources such as fossil fuels are realized.

Solar Power Concentrated (PhotoVoltaics) (CSP;CPV)**:** use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam capable of producing high temperatures and correspondingly high thermodynamic efficiencies. Concentrating solar is generally associated with solar thermal applications but concentrating photovoltaic (CPV) applications exist as well and these technologies also exhibit improved efficiencies. CSP systems require direct insolation to operate properly. Concentrating solar power systems vary in the way they track the sun and focus light.

Solar (ir)radiation: radiant energy emitted by the sun, particularly electromagnetic energy. About half of the radiation is in the visible short-wave part of the electromagnetic spectrum. The other half is mostly in the near-infrared part, with some in the ultraviolet part of the spectrum [1]. The portion of this ultraviolet radiation that is not absorbed by the atmosphere produces a suntan or a sunburn on people who have been in sunlight for extended periods of time.
Daily total solar irradiation: describes the radiant energy emitted by the sun over all wavelengths that falls each second on 1 square meter outside the earth's atmosphere--a quantity proportional to the "solar constant" observed earlier in this century. It measures the solar energy flux in Watts/square meter.

Solar wind: A stream of particles, mostly electrons and protons, flowing out from the Sun at

speeds of 5-10 km/s. As it flows out, the solar wind accelerates and can reach speeds as high as 900 km/s. The solar wind is the result of the hot solar corona expanding into space.

Sun-Earth distance: varies during the year, but on average it is approximately 150,000,000 km or 93,000,000 miles.

Under-voltage: a condition where the potential is inadequate to power equipment, and may damage it. "Brown-outs" are forms of under-voltage caused by excessive demands on a utility's resources. In a home system or in a utility system, controls are installed to turn the power off when it is sufficiently under-voltage.

Ultra Violet-Light (UV): means "beyond violet", from Latin *ultra.* UV**-**light is electromagnetic radiation with a wavelength shorter than that of visible light, with violet being the color of the shortest wavelengths of visible light, but longer than soft X-rays.

Wp – Watt-peak: A standard measure (unit) being used to compare the power of solar cells or panels. In practice the power rating is determined by measuring the maximum power it will supply when exposed to radiation from lamps designed to reproduce the AM1,5 spectral distribution at a total power density of 1000W/$m^{-2.}$ In practice a solar panel reaches in general only 80% of the Watt-peak power.

Sources:

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