Tags

Edited Feb 8, 2021 6:47 AM by admin…

Energy on our HPA campus

APES notes Energy

Renewable energy on our campus:

Solar PV: radiation from the sun (visible) making electrons move in a special semiconductor material (silicon, made from sand), so photo (light) voltaic (Volts) = PV or photovoltaic. These release direct current (+ and –) energy like a battery. To be used in our electrical system, we use an inverter to change the DC to AC (alternating current). Inverters are large boxes that are usually hot when in use. PV panels are usually made of glass, often with a purple color, which is the semiconductor below.

Solar Thermal: radiation from the sun (visible) hits a dark metallic surface (often copper or aluminum, since they conduct heat well). The dark surface transforms visible radiation into thermal (infrared) energy, which is conducted by the copper or aluminum to attached water pipes. To keep the heat energy from radiating away from the panel, the metal is coated with a special paint, and covered with a special glass insulating layer. The glass is the heaviest part!

Wind energy: Solar radiation (mainly visible) heats the surface (water or ground) which makes the air in contact with the surface less dense, so it rises into the atmosphere. Wind is the movement of air to replace this rising air. Since air has mass, when is passes over a surface that can move, the kinetic energy of the wind (1/2mv2) can push a wing. Two or more wings working together will rotate a shaft that can be connected to a generator (Direct current, DC) or an alternator (alternating current, AC). Turbines can be horizontal axis (HAWT) or vertical axis (VAWT), which are less popular. Horizontal axis turbines can be leading or trailing, meaning the blades are in front of or behind the tower. Most large turbines are leading, because of the turbulence from the mast.

Storage:

Hot water: the cheapest energy storage method is hot water, usually from solar thermal panels, but can also be from PV panels running a traditional electric hot water heater, just like a coffee maker. Insulation is a key aspect to hot water storage, as heat travels from hot to cold through conduction (contact) radiation (radiation) or convection (hot air rising). Most hot water heaters are insulated (conduction), reflective (radiation) and covered (convection).

Batteries: These can be old style lead acid batteries like those in a car or golf cart, or newer lithium batteries like those in electric vehicles or in our IT and student union setups. Batteries only store Direct Current (DC), so they must go through an inverter to supply the grid, which is alternating current (AC). Energy stored in a battery can be as cheap as $100 per kWh stored for lead acid batteries, or up to $500 per kWh for lithium batteries, which charge much faster, last longer, and are much better for the environment than lead acid batteries.

Hydrogen: Passing direct current energy through water splits the water in to its components, Hydrogen and Oxygen. If the Hydrogen is captured and compressed, it can be used to burn for heating, cooking or in vehicles, or if passed through a special Fuel Cell membrane into direct current electricity, just like a battery as well as hot water. This is not as efficient as a battery, but can be used for long term storage.

Conservation:

Every dollar spent on conservation is worth 8 dollars in new renewable energy systems. Some key places to conserve energy:

Hot water insulation and timers

Passive ventilation vs. air conditioning

Lighting LED and passive

Vampire load reduction

Smart use of resources, occupancy based energy use

Energy units:

1 Joule is the basic unit of work or energy

1 Joule used or produced every second is called a Watt, so 1 Watt = 1 joule/sec

1000 Watts is 1 kiloWatt or kW

1 kW used or produced for one hour equals one kiloWatt-hour or kWh. A truly goofy term, but something easy to measure:

1000 Watt coffee pot running for 1 hour: 1 kW x 1 hour = 1 kWh

This is attached to cost, so the electric utility may charge you 2 cents for a kWh in Oregon, or 45 cents per kWh here in Hawaii–why?