Resolving charge controller confliction in hybrid charging systems

Charge controller confliction occurs when a site features multiple charging sources (wind, solar, fuel cell, generator, etc) however each charge controller is adjusted to the same diversion or "yield point" with regards to battery charging levels.

A basic example of this would be a 12 VDC site with solar and wind charging systems where both charge controllers are set to the optimal charge level of 14.4 volts. In this situation the charge systems (solar and wind) would be in conflict, as each attempts to bring and maintain the battery charge level to the same voltage.

To avoid this conflict, the charge controller set point for each of the incoming charge sources must be stepped so that each can individually charge the battery to an acceptable level, but not the same level.

For example, the charge sources installed at a hypothetical off-grid site include a fuel cell, a wind turbine and a solar panel array. For a 12-volt system, a typical charge controller set point plan would be to set the fuel cell charge controller to 14.0 volts, the solar charge controller to 14.2 volts, and the wind turbine charge controller to a maximum charge level / diversion set point of 14.4 volts.

For a similar site with a 24-volt system, the fuel cell charge controller would be set to 28.4 volts, the solar charge controller to 28.6 and the wind turbine charge controller to a diversion set point of 28.8 volts.

When using quality charge controllers that are stable during all phases of operation, the offset levels between each of the charge sources can be reduced from 0.2 to 0.1 volts.

To implement the above charging strategy, several of the charge regulators or controllers must be adjustable to avoid charge controller conflict. At a minimum, if two of the three charge sources in the above example are adjustable, then charge controller conflict can be avoided.

Addressing charge fluctuations due to solar and wind availability

Note that the above set point voltages are higher than the stated battery voltages of 12 and 24 volts. The purpose of this is to address the fluctuations in power generation that is endemic of any renewable energy (RE) system.

If, for example, a 24-volt system battery is being charged by a utility powered electric battery charger, a constant 27.8 to 28.2 volts with amp adjustments to near zero would be appropriate. However, for a three step PWM Temperature compensated charge controller managing the fluctuating amps produced by varying wind and solar, the batteries require a slightly higher charge and 28.8 (2.4V x 12 - 2V Cells making a 24-volt system) is recommended.

For most 24-volt system banks (AGMs and VLA batteries) 28.8 volts is the upper charge limit and charge controller diversion set point. This ensures that the battery is not over charged, but is fully charged to 100%.

Who's the boss?

While the above examples show wind as the dominate source of renewable energy, the actual hierarchy between wind and solar depends on the most available renewable energy resource, as well as the size of the RE generator. For the vast majority of off-grid sites the wind turbine will be set higher, as the wind blows day and night and has the potential ability to take the battery / bank to a 100% SOC (State Of Charge) at any time.

For off-grid sites located in extremely hot climates (such as deserts) that feature large solar panel arrays, a better strategy would be to set solar (PV) as the primary RE recharge source, with the wind turbine helping the solar panels to maintain battery charge at night.

Why wind should typically dominate the RE hierarchy

Solar charge control systems typically charge a battery to 98% SOC, after which they stop or regulate output by shorting the solar panels. This means that in a 12-volt system, a solar charge controller set point of 14.4 volts is not an active diversion setting.

During early morning and late afternoon hours, a small amount of light falling on a large solar panel will generate enough electrons to create high voltage with no amps (compared to a wind turbine, which always generates both voltage and amperage).

If the wind turbine charge controller set point is lower than the PV set point, this high voltage / no amp situation created by the solar panels can “trick” the wind turbine into yielding or diverting available charging power away from the battery.

Ninety percent of a solar panel’s output is generated between 1000 and 1500, when the sun is at it’s highest – a maximum of five to six hours per day. By comparison, wind power (in an average wind location) can be available for use 24 hours.

During winter months available sunlight is further reduced, making it even more crucial for the wind turbine’s charge controller set point to be higher than any accompanying solar set point.

Charge diversion – the saving grace of your renewable energy powered off-grid site

A wind or solar charge controller serves two functions. The first is to direct power from the RE to the battery, allowing it to achieve a 100% SOC. The second, equally important purpose is to monitor the SOC of the battery and once that maximum voltage is reached, to safely divert excess power generated by the RE to an appropriate diversion load (aka a dump load) resistor bank.

The diversion load resistors must be appropriate for the charging system(s) being diverted. The resistors should be calibrated, outdoor rated and of commercial quality. Avoid cheap ceramic resistors that can fail and pose a possible fire hazard.

It is always better to have a separate charge controller for each RE utilized in a hybrid system. The solar charging system should feature an appropriate solar charge controller, while the wind charging system should also have its own dedicated charge controller. It is never recommended that both solar and wind charging systems utilize a single “one source” charge regulation strategy. This approach introduces a single point of failure, which can disable both solar and wind charging systems in the event of a charge regulator casualty.

Finally, a charge controller should divert excess power generated by the RE before it reaches the battery, not from the battery. This is especially crucial when charging lithium ion batteries.

For more information please contact Mission Critical Energy at (716) 276-8465 or visit us at www.missioncriticalenergy.com.