Test 1 Questions Stand-Alone

1. Describe the term Stand-Alone when it comes to renewable energy.
   1. The term stand alone comes from the independence of connecting to a utility grid.
2. Name the four main components for a stand-alone system.
   1. Battery
   2. PV panel
   3. Charge controller
   4. Inverter
3. What are the 3 primary reasons why a battery storage source is used?
   1. Autonomy.
      1. A battery provides flexibility as stored energy can be drawn on demand.
      2. Energy can be supplied during periods of low or no sunlight, such as on cloudy days or at night when the PV modules are producing little or insufficient power to supply the electrical load or demand.
   2. Stable Voltage.
      1. The voltage produced by a PV panel alone changes depending on the load.
      2. The energy from a battery, on the other hand, is produced over a reasonably stable voltage range.
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4. Describe the two basic types of batteries.
   1. Primary batteries are one use only and can’t be recharged.
   2. Secondary batteries will recharge when the discharge current is reversed.
5. There are three main common battery types for stand-alone applications in Belize. Name them.
   1. Lead Acid
   2. Lithium Ion
   3. Nickel Iron
6. Within the lead acid family of batteries are three main types.
   1. Flooded
   2. Gel
   3. AGM (Absorb Glass Mat)
7. Name 3 characteristics of a Flooded Battery.
   1. Flooded or (Wet) Cell is the original Lead acid battery and the oldest type of secondary battery.
   2. They have a lower energy to weight ratio compared to the AGM and Gel types.
   3. Their ability to supply high surge currents and their low cost, make them attractive for use in the inverter applications.
8. VRLA batteries are commonly further classified as:
   1. Absorbent glass mat (AGM)
   2. Gel battery.
9. Gel is a class of a VRLA battery, describe it.
   1. With a gel like electrolyte, the sulfuric acid is mixed with a silica fume (also used in concrete), which makes the resulting mass gel-like and immobile.
   2. In addition, Gel batteries virtually eliminate electrolyte evaporation, spillage common to wet-cell batteries, and boast greater resistance to extreme temperatures, shock, and vibration.
10. Describe an Absorbed Glass Mat (AGM)
    1. It is a class of a VRLA (Valve regulated Lead Acid) battery in which the electrolyte is absorbed into a mat of glass fibers.
    2. Their unique (for lead acid chemistries) construction also allows for the lead in their plates to be purer as they no longer need to support their own weight as in traditional cells.
11. The 100% SoC (State of Charge) for lead acid batteries is when the cell voltage reaches
    1. 2.11Volts.
12. For 12volt battery the fully charged voltage is
    1. 12.65V
13. For 0% SoC for lead acid batteries is when the cell voltage reaches
    1. 1.75 Volts.
14. For 12volt battery the fully discharged voltage is
    1. 10.50Volts.
15. Describe the Nickel Iron Battery.
    1. Nickel Iron battery is rated for at least 11,000 cycles with daily use.
    2. That’s 30 years of service.
    3. Daily deep discharging has no impact on battery cycle life, allowing for more usable capacity.
    4. Never have to worry about accidental over-discharge damaging the battery bank.
    5. Nickel Iron is tolerant of over-charge, over-discharge, and below freezing temperatures.
    6. The alkaline electrolyte acts as a metal preservative, leading to years of uninterruptible performance.
16. Describe the Lithium-ion Battery.
    1. Lithium is a very light metal and has the best electrochemical potential with the largest energy density compared to weight.
    2. Lithium-ion batteries have a high cell voltage of 3.6 volts.
    3. Four cells make a battery of 14.4 volts.
    4. The voltage of a fully charged cell is 4.0 V.
    5. The average voltage of a cell is 3.6 V and reduces to 3.1 V when fully discharged.
17. Describe Deep Discharge Batteries:
    1. Are designed for the prolonged, repeated, and deep charging/discharging cycles needed to store and distribute energy generated by intermittent renewable sources like solar panels.
18. Describe DEPTH OF DISCHARGE
    1. Depth of Discharge (DOD), is used to describe how deeply the battery has been discharged.
    2. A battery which is 100% fully charged would have a DOD of 0%.
    3. A battery which has been discharged by 20% of its capacity, maintaining 80% of its capacity, would have a DOD of 20%.
    4. If a battery has been completely discharged with no remaining capacity, the DOD is 100%
19. Describe CYCLE LIFE
    1. Battery manufacturers rate the cycle life of their batteries by comparing the level of discharge on the battery and the frequency of cycling.
    2. Higher battery discharge will result in shorter cycle life.
    3. In reverse, a smaller discharge percentage will extend the expected cycle life of the battery as the battery will provide more charge/discharges
20. Describe Ampere Hour Capacity
    1. A unit measure for the rated capacity of the storage batteries.
    2. Typical manufacture ratings found on the battery sheet are in 1, 6, 20, and 100 Hour intervals.
    3. An amp-hour is one amp for one hour, or 10 amps for 1/10 of an hour and so forth.
    4. If you have something that pulls 20 amps, and you use it for 20 minutes, then the amp-hours used would be 20 (amps) X .333 (hours), or 6.67 AH.
    5. The accepted AH rating time period for batteries used in solar electric and backup power systems (and for nearly all deep cycle batteries) is the "20 hour rate".
21. Describe LOW VOLTAGE DISCONNECT (LVD OR LVCO)
    1. Many charging systems offer the ability to program a Low Voltage Disconnect (LVD) or Cut Off (LVCO) which can remove the load from the battery or start a backup generator.
    2. By default, this may be set by the charger manufacturer at 1.75 volts per cell (VPC)(Lead acid).
22. Describe Charge Rate:
    1. Current applied to a cell to restore its capacity.
    2. Charge rate is usually expressed in terms of the cell's C Rate.
    3. This rate is also commonly expressed as a fraction of the capacity of the battery.
23. Describe Self Discharge:
    1. Discharge that takes place while the battery is in an open-circuit condition.
24. Describe State of Charge (SOC):
    1. The amount of deliverable low-rate electrical energy stored in a battery at a given time expressed as a percentage of the energy when fully charged and measured under the same discharge conditions.
    2. If the battery is fully charged, the state of charge is said to be 100 percent.
    3. Name 7 steps when sizing the battery capacity for a very basic stand-alone (DC only) system?
    4. Calculate the time the connected devices are used everyday
    5. Find the wattage of them
    6. Calculate the Whr required for the devices
    7. Define the nominal battery voltage
    8. Calculate the Ahr required for the devices
    9. Add days of autonomy
    10. Apply the DoD
25. How many cycles will this battery have at 50% DoD?

Chart, line chart

Description automatically generated

1. Approximately 4300
2. Lead acid deep cycle batteries should be used to a maximum ??% DOD as this offers a balance between capacity vs. cycle life, also taking into consideration the cost of replacement.
   1. 50%
3. What things need to be considered for the battery capacity when adding an inverter?
   1. The DC current to power up the inverter
   2. The efficiency of the inverter
4. What is the advantage of having some loads on the system being DC?
   1. More efficient, no AC invert energy
   2. Can be used when the inverter is turned off
5. Describe multi-stage charging.
   1. It is a charger that has Bulk, Absorb and Float charging stages, may also have Equalizing stage.
6. Describe BULK CHARGE
   1. The first of the three-phase charging process is the Bulk charge.
   2. During this stage the maximum amount of current flows into the battery bank until a desired programmed voltage is reached.
7. Describe ABSORPTION CHARGE
   1. The second and most important phase of the charge cycle is the Absorption charge.
   2. The Bulk charge typically brings the battery bank to approximately 80% SOC.
   3. Once reached, the charger will then switch to the programmed Absorption voltage to complete the charging cycle.
8. Describe FLOAT CHARGE
   1. When the Absorption charge phase has completed and the batteries have reached 100% SOC, the charger will continue to output at a lower voltage setting known as Float.
   2. Float voltage maintains the battery bank at a constant 100% SOC until the charge output diminishes (Ex: solar) and/or a load is applied which begins to discharge the battery bank.
9. Describe EQUALIZATION
   1. Over time, individual cell readings may vary slightly in specific gravity due to charge imbalance or sulfation buildup.
   2. Individual cell readings will vary slightly in specific gravity after a charging cycle.
   3. Equalization, or a “controlled overcharge", is required to bring each battery plate to a fully charged condition.
10. What Is a Solar Charge Controller?
    1. An essential part of nearly all battery-based renewable energy systems, charge controllers serve as a current and/or voltage regulator to protect batteries from overcharging.
    2. Their purpose is to keep your deep cycle batteries properly fed and safe for the long term.
    3. Solar charge controllers are a necessity for the safe and efficient charging of solar batteries.
    4. Think of the charge controller as a strict regulator between your solar panels and solar battery.
    5. Without a charge controller, solar panels can continue to deliver power to a battery past the point of a full charge, resulting in damage to the battery and a potentially dangerous situation.
11. Describe PWM charge controllers
    1. They are inexpensive and reliable.
    2. Their drawback is that they should only be used when the nominal voltage of the solar panels matches the battery voltage – and even then, they have inefficiencies in larger systems.
    3. PWM is pulse width modulation.
    4. A PWM (Pulse Width Modulation) charge controller features a battery that is connected to the solar energy source via an electronic switch.
    5. When the battery reaches a full charge, the electrical current is gradually reduced until it arrives at a low-maintenance state (where it will then stay).
    6. PWM charge controllers are for small-scale applications where the nominal voltage of the solar array matches the battery bank voltage.
12. Describe Maximum Power Point Tracking (MPPT) Controllers
    1. MPPT charge controllers are the highest-quality, most advanced option available, but they come with the high prices to match.
    2. MPPT controllers provide an impressive 94-98% efficiency level, delivering about 10-30% more power to the solar battery than other types.
    3. Unless your solar system is small (cabin-sized or smaller) and its battery voltage is no more than 24V, an MPPT controller is usually worth the extra initial investment.
    4. With larger, more advanced systems and 48V battery banks becoming much more common over the years, MPPT charge controllers are the new standard.
13. What is the purpose of the Remote Temperature Sensor?
    1. To adjust the charging voltage from the charge controller as the battery temperature changes.
14. Describe the Load Control Feature.
    1. The primary purpose of the load control function is to disconnect system loads when the battery has discharged to a low state of charge, and reconnect system loads when the battery is sufficiently recharged.
15. Why is the C-20 rate lower than the C-100 rate for discharging?
    1. The C-20 rate is over a 20 hour period, the C-100 rate is over a 100 hour period. The faster the battery discharges, the more heat is dissipated in the battery which is a loss. The battery is less efficient at the faster discharging.
16. Describe how the MPPT charge controller work internally.
    1. The MPPT (Maximum Power Point Tracker) charge controller uses an electronic chopping circuit to harvest the PV energy.
    2. This type of charge controller turns off and on an electronic switch just like the PWM.
    3. Instead of a switch placing the PV across the battery, it places the short-circuiting current into an inductor.
    4. The inductor stores the energy in a magnetic field around the windings (wire) of the inductor.
    5. When the switch opens the stored magnetic field collapses and induces current into the coil, which is now connected to a capacitor to form a DC bus.
    6. The rate at which the switch depends on the amount of current that can be captured in the magnetic field.
    7. Slower on cloudy times and faster on sunny times.
17. Can the same charge controller be used on Lead acid and Lithium batteries?
    1. Yes, some can, not all.
18. What does this stand for (BMS)?
    1. BATTERY MANAGEMENT SYSTEM
19. Typically, what type of battery technology uses a BMS?
    1. Lithium
20. A power inverter is a device that?
    1. Is usually used to convert electrical power from DC form to AC using electronic / electrical components.
21. Inverters, like most devices, come in varying qualities. Describe the basic differences.
    1. The basic output difference for most is divided into square-wave, modified sine wave, and pure sine wave.
22. Describe the modified sine wave topologies.
    1. (which are actually modified square waves) produce square waves with some dead spots between positive and negative half-cycles they are suitable for many electronic loads, although their THD( Total harmonic Distortion) is about 25%.
23. Define Power Factor
    1. (PF): It is denoted by “PF” and is equal to the ratio of the Active Power (P) in Watts to the Apparent Power (S) in VA.
    2. The maximum value is 1 for resistive types of loads where the Active Power (P) in Watts = the Apparent Power (S) in VA.
    3. It is 0 for purely inductive or purely capacitive loads.
24. Describe Active Power (P)
    1. Watts: It is denoted as “P” and the unit is “Watt”.
    2. It is the power that is consumed in the resistive elements of the load.
25. What effect do reactive loads have on the rating of inverters?
    1. Reactive types of loads will draw higher value of “Apparent Power” that is the sum of “Active and Reactive Powers”.
    2. Thus, AC power source should be sized based on the higher “Apparent Power” Rating in (VA) for all Reactive Types of AC loads.
    3. If the AC power source is sized based on the lower “Active Power” Rating in Watts (W), the AC power source may be subjected to overload conditions when powering Reactive Type of loads.
26. The voltage is 120VAC, Wattage is 8W and current draw is 85mA. Describe this load! (It is an LED bulb that is capactive)
    1. The VA = 120V x .085A = 10.2 VA
    2. PF = (True power)/(Apparent power) PF = W/VA
    3. The current on the AC side is 85mA and 10.2VA with a PF of .78 capacitive (Switching power supply).
    4. The current on the DC side is 8W / Battery voltage.
    5. The inverter will supply the VARs on the AC side.
    6. Inverter capacity x Power Factor = Active Power
27. The batteries have an approximate XX% efficiency in round trip charging.
    1. 85%