Solar & Backup Power System Design

Solar System Design - 8 easy steps to determine which components and power requirements are necessary to meet your needs.

1. Equipment / Appliance Load
2. Days of Autonomy (Typically 2-3 days)
3. Battery Bank Size - Ah
4. Solar Panel Array Size - Watts
5. Charge Controller Size - Amps
6. Inverter (DC - AC) Size - Watts (if applicable)
7. Wire Gauge / Crimp Fittings etc.
8. Fuses / Breakers (1.25% of Amp Rating)

Potential Benefits -

-Reduce RFI
-Reduce Operation Costs
- Provide Emergency Backup Power
-Extend Operating Time of Battery Capacity
-Mobile Operations

System Design / Layout -

Simplest method for determining solar system design requirements and calculations is to first convert everything to Watts and Watt Hours. This allows for easy and quick comparison between components.

Needed Information for Determining System Sizing Requirements:

-Electrical Load for each appliance or piece of equipment planned to be powered by Solar and Battery Backup system.
-Length of time each appliance or piece of equipment will be operated within a 24 hour period.
-Desired Days of Autonomy - (The number of days the total equipment load can be operated independent of AC power or Solar power). Determines the needed Ah rating of the battery bank.

Component Power Rating Selection - (Convert each to Watts or Watt Hours where applicable)

-Battery Bank size in Ah. (Amp Hours x Volts = Watt Hours)
-Panel Size in Watts.. Based on 5-7 hours of Full Sun, and is dependent on location.
-Charge Controller Rating in Amps. Based on Solar Panel Array and Manufacturer Spec Info.
-Inverter in Watts. Based on AC appliance load requirements.

Component Cost Estimates - Includes some component brand considerations

-Batteries: Many benefits, including long term reduced cost, in LiFePo4 over Lead-Acid

1. BattleBorn LiFePo4 100ah $950
2. Renogy LiFePo4 100ah $800
3. SOK LiFePo4 100ah $600
4. Ampere LiFePo4 100ah $500
5. Raw Cell Build w/BMS (Batt Management System) 100ah $500-800

-Solar Panels: No significant differences between Mono vs Poly in small systems

1. Rich Solar 100w Monocrystalline $85
2. Renogy Solar 100w Monocrystalline $105
3. HQST Solar 100w Monocrystalline $100

-Solar Charge Controller:

1. EPEver MPPT 40a $175
2. Renogy MPPT 40a $140
3. Victron MPPT 30a $200
4. Rich Solar MPPT 20a $115

-Inverters: Ideally Pure Sine Wave

1. Giandel PSW 1200w/2400w $200
2. Giandel PSW 2200w/4400w $340
3. Bestek PSW 500w/1000w $80
4. GoWise PSW 600w/1200w $100
5. Aims PSW 1500w/3000w $285
6. Aims PSW 2000w/4000w $360

-Other System Cost Considerations:

1. Solar Cables
2. Solar Splitter Fittings
3. Various Crimp Fittings
4. Shrink Wrap
5. Battery Cables
6. Fuses & Breakers

7. Solar Panel Mounts

All-In-One Power Station Options - (Sometimes referred to as Solar Generators)

-Jackery Explorer 300 - Provides 293 Wh. Cost approx $300
-Jackery Explorer 1000 - Provides 1002 Wh. Cost approx $900
-Bluetti AC30 - Provides 300 Wh. Cost approx $300
-Bluetti AC200P - Provides 2000 Wh. Cost approx $1800
-ExpertPower Alpha 400 - Provides 444 Wh. Cost approx $450

Design Calculation Formulas -

-Appliance / Equipment Load - (Watts x Hrs Used = Watt Hour Rating)
-Battery Bank - (Amp Hrs x Volts = Watt Hours)
-Solar Panel Array - (Amps x Volts = Watts)
-Charge Controller - (Solar Watts / Batt Volts = Amp Rating)

Useful References -

mobile-solarpower.com - Great Solar & Backup Power Information
bluesea.com - AWG Chart
renogy.com/calculator - Cable Calculations
generatorist.com - Appliance Power Consumption Chart

Example **Solar & Battery Backup System Build -**

1. **Power Load - both AC and DC - (Watts x Hrs Used = Watt Hours)**
   -60w Light - 3 hrs (60w x 3hrs = 180wh)
   -24w Radio - 6 hrs (24w x 6hrs = 144wh)
   -70w Fan - 5 hrs (70w x 5hrs = 350wh)
   -1000w Microwave - .5 hrs (1000w x .5hrs = 500wh)
   Total = 1174 wh (Round up to 1200wh)

2. **Days of Autonomy - (Typically 2-3 Days)**
   -2 Days: (support wh load for 2 days without AC or Solar power)
   (1200wh DC Load x 2 days = 2400wh)

3. **Battery Bank - (Amp Hrs x Volts = Watt Hrs)**
   -We will use a 100ah Lithium Battery:
   (100ah x 12 volts = 1200wh)
   (2400wh Load / 1200wh Batt = 2 Batteries Required)
   Estimated Cost $1400

4. **Solar Panels - (Amps x Volts = Watts)**
   -We will use 100w Solar Panels:
   (2400wh Load / 6 hrs Full Sun = 400w Solar Panel Array) - or 4 each 100w panels
   Estimated Cost $420

5. **Charge Controller - (Solar Watts / Battery Volts = Amp Rating)**
   -Need to determine amp rating related to solar array:
   (400w Solar Panels / 12 volt Batteries = 33.3 Amps Minimum)
   (Round up to 40a Controller)
   Estimated Cost $150

6. **Inverter (DC to AC)**
   -If applicable, need to determine AC Watt Rating required.
   -Simply add up the wattage of all AC appliances/equipment calculated in step 1.
   -The inverter needs to be larger than the AC load. The larger the inverter the better.
   Estimated Cost for 2000w PSW $350

7. **Wire & Cable**
   -Reference AWG Chart for:
   Solar Panels to Charge Controller
   Battery to Charge Controller
   Battery to Inverter
   Charge Controller to DC Distribution (rigrunner or fuse block)
   Fuse Block to DC Equipment
   Estimated Cost $120-180

8. **Fuses & Breakers**
   -Between Battery and Charge Controller (rule of thumb is 1.25% of charge controller amp rating:
   (40a Charge Controller x 1.25 = 50a Fuse or Breaker)
   (1200w Inverter / 12v Batteries = 100a x 1.25 = 120a Fuse or Breaker)
   Estimated Cost $80-100

Total Solar & Battery Backup *Example* System Estimated Cost $2500-2600

NOTES: