Emergency Power

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Emergency Power Requirement Estimate

Appliance	Rated Watts	x Hours/day	Surge Watts	Surge Watts
Light Bulbs (75 watt each)	75 x number	____________	75 x number	____________
Compact fluorescent (25/100 watt)	25 x number	____________	25 x number	____________
Refrigerator/Freezer	500	____________	2000	____________
Sump Pump	800	____________	2000	____________
Water Pump (1/3 HP)	1000	____________	3000	____________
Furnace Fan (1/2 HP)	875	____________	2300	____________
Electric Blanket	400	____________	400	____________
Space Heater	1800	____________	1800	____________
Heat Pump	4700	____________	12000	____________
Dehumidifier	650	____________	800	____________
Attic Fan	300	____________	900	____________
Table Fan	800	____________	2000	____________
Window Air Conditioner	1200	____________	4800	____________
Central Air (10k BTU)	1500	____________	6000	____________
Central Air (24k BTU)	3800	____________	15000	____________
Central Air (40k BTU)	6000	____________	24000	____________
Computer	300	____________	300	____________
CD Player	100	____________	100	____________
VCR	100	____________	100	____________
Radio	100	____________	100	____________
Television	300	____________	300	____________

Receiver	420	____________	420	____________
Microwave	800	____________	800	____________
Blender	300	____________	900	____________
Coffee Maker	1500	____________	1500	____________
Electric Range (1 element)	1500	____________	1500	____________
Toaster (2-slice)	1000	____________	1600	____________
Dishwasher (Hot Dry)	1500	____________	3000	____________
Electric Oven	3410	____________	3410	____________
Steam Iron	1200	____________	1200	____________
Washing Machine	1150	____________	3400	____________
Gas Clothes Dryer	700	____________	2500	____________
Electric Clothes Dryer	5400	____________	6750	____________
Security System	500	____________	500	____________
Deep Freezer	500	____________	1000	____________
Hair Dryer	1200	____________	1200	____________
Garage Door Opener (1/3 HP)	750	____________	750	____________
Electric Water Heater	4000	____________	4000	____________
Total Per Day		____________		____________

Note: the generator must be able to handle the total surge power.

Note: Compact fluorescent (25/100 watt) bulbs provide an equivalent of 100 watts of light and use 25 watts of power.

Generators

Generators are basically gasoline, natural gas, or propane powered. They usually generate substantial amounts of power. Portable generators commonly generate 1,000 to 5,000 watts continuously with a surge of about 1,300 to 6,500 watts. There are several disadvantages of gasoline powered generators. They require a constant refilling of gasoline and gasoline cannot be stored for long periods of time. Gasoline stations require electric pumps to supply gasoline and they may not have emergency generators. Natural gas is often available in many homes. Propane can be stored. Propane tanks are usually refilled by gas pressure, which eliminates the need for electric pumps.

Solar Power

Solar power is far more expensive than generator power. There are several advantages of using solar power. Sunshine is the source of power, which eliminates dependency on vendors for fuel. Solar power is clean and requires little maintenance. The disadvantage is initial cost. Typically, solar power is used to charge batteries, which are connected to an inverter.

A solar cell or photovoltaic cell (PV) is made of semiconductors, usually silicon. Ordinarily pure silicon is a poor conductor of electricity so impurities such as phosphorus and boron are added to create the semi-conductor. The addition of these impurities allows the silicon to conduct electricity. The semiconductor absorbs part of the light. The absorbed light energy knocks electrons loose, allowing them to flow freely. Metal contacts are placed on the top and bottom of the solar cell so that current can be drawn from it.

A solar electric panel consists of an aluminum framed sheet of highly durable low reflective, tempered glass that has had individual solar cells adhered to the inner glass surface. These individual solar cells are wired together in a series parallel configuration to obtain the necessary voltage and current. The back of the panel is protected by another sheet of tempered glass or a long lasting material such as Tedlar. The series parallel connections are passed through the protective backing and then wired to a weather proof junction box which is permanently mounted to the back of the panel where the panel's output connections are made. There are also flexible cells and panels, roof tile cells, etc.

Solar panels are rated as watts per hour. For example, in direct sunlight, a 50 watt solar panel will produce 50 watts per hour. It will produce 350 watts in 7 hours, and so on.

Batteries

When designing a marine deep cycle battery, manufacturers must keep in mind that the battery may be used for starting a boats engine. In order to start an engine, the battery must contain a lot of plates and plate area, which give the battery its high cranking capacity. In order to squeeze enough plates into a standard battery case, the plates must be made thin. The thinner the plates the shorter the life span of the battery when it is used in a deep cycle application. If cost is a major factor and the batteries will only be used occasionally during an emergency, a marine deep cycle battery may be adequate.

A much better choice for long-term continuous use is the golf cart battery. The plates are much thicker and designed to be deep cycled below 50% depth of discharge day in and day out, year after year. A properly maintained golf cart battery should last 3 two 5 years in a typical renewable energy application. A typical golf cart battery is available in a 6 volt 220 amp hour ratings. Two batteries will be required and they will need to be wired in series to produce 12 volts @ 220 amp hours. Golf cart batteries are considered the minimum type of battery that is used in renewable energy application. There are larger batteries available in 6, 4 and even 2 volt configurations which have even larger plates and thus longer life expectancies.

When there is power available from the utility company, batteries can be charged from the power line. During emergencies, when there is no power from the utility company, batteries will have to be charged from the solar panel.

Calculating Battery Usage:

Amp Hour x Volts (Watts)
--------------------------------- = Watts per Hour
Hours of Use

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--------------------------------- = Hours of Use
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Example:
A 12 volt, 100 ah battery will provide:
100 amps in 1 hour (1200 watts in 1 hour)
14.3 amps for 7 hours (171 watts in 7 hours)
5 amps for 20 hours (60 watts in 20 hours)

Calculating the Load:

Watt Hours = Load Watts x Hours of Use
Add 10 percent for battery losses.

Example: If a television draws 200 watts and runs for three hours (200 x 3 = 600) it will use 600 watt hours

Inverters

An inverter is an electronic device, which inverts DC energy AC energy. Most household appliances such as refrigerators, TVs, lighting, stereos, computer etc., all run off of AC electricity.

Modern DC to AC inverters are very reliable, quiet, and require virtually no maintenance. There are two different types of DC to AC inverters in common use today. The first type of inverter is known as a modified sine wave inverter. This type of inverter is very high in efficiency and produces a waveform, which is an approximation of the pure sine wave waveform.

High frequency units take the incoming 12 Volts DC and will step up that voltage to approximately 200 volts DC through a high frequency DC to DC converter circuit and then will take the 200 Volts and will wave shape it into a modified sine wave using a using a device called a high voltage H-bridge. The high voltage H-bridge is basically a group of field effect transistors that are arranged in such a way as to form the necessary half cycles that create the modified sine wave at the 60 Hz frequency required for US appliances. By utilizing high frequency, the need for a large iron core output transformer is eliminated and much smaller transformers can be used. As a result of this, high frequency inverters tend to be much lighter but do have a lower surge capacity because they lack the fly wheel effect found in heavy iron core output transformer based inverters.

Low frequency units take the incoming 12 Volts DC and converts it into AC, using a multivibrator or microprocessor based circuit. The AC is kept at a low voltage and is converted into a 60 Hz signal before it is fed to the iron core transformer. Wave shaping and the increased current that is needed to drive the transformer is performed again by an H-bridge which is a group of field effect transistors that are arranged in such a way as to feed high current pulses to the primary windings of the transformer at precise moments of each wave form half cycle. The transformer converts the lower voltage which was fed to its primary windings into 120 Volts AC at its secondary windings using simple transformer step up principles involving a 10 to 1 ratio, converting 12 Volts AC to 120 AC. This type of inverter is more durable than the high frequency inverters, and has a much higher surge capacity. Low frequency units tend to cost two to five times more than do high frequency units and often weigh four times more.

The second type of inverter is known as a pure sine wave inverter. This type of inverter produces pure sine waves, but at the cost of some efficiency loss and at a much higher price. Most pure sine wave inverters are typically priced at least 75% higher than the modified sine wave counterparts and in some cases do not have as high of a surge capability as do modified sine wave units.

A 3,000 Watt, 120 VAC, Output Solar System

The Batteries will need to supply 3,600 watts of electricity per hour, 86,400 watts per day. The inverter efficiency is about 71 percent. Therefore 3,600 watts DC will be needed to convert to 3,000 watts AC. The solar panels will need to charge the batteries with 86,400 watts during sunlight (about 7 hours per day) at the rate of 12,342.9 watts per hour. The system will require a space of about 30 feet x 30 feet, weigh more than 7,000 pounds, and cost over $60,000.

<u>Calculate Time of Battery Use:</u>

$$\frac{\text{Amp Hour x Volts (Watts)}}{\text{Watts per Hour}} = \text{Hours of Use} = \frac{\text{400 ah x 6 volts x 36 batteries}}{\text{3600 watts per hour (150 a x 24 v)}} = \text{24 hours}$$

<u>Calculate Time of Battery Recharge from Solar Panels:</u>

$$\frac{\text{Amp Hours x Volts (Watts)}}{\text{Solar Panel Watts}} = \frac{\text{400 ah x 6 volts x 36 batteries}}{\text{66 x 185 watts per hour}} = \text{7.1 hours}$$

The system consists of:
Sixty Six 185 watt, 24 v solar panels, 62” x 32.5” x 1.8", 38 pounds, (about $50,000)
Connected in parallel (923.6 square feet [30’ x 30’], 2,508 pounds)
3,600 watt output, 24 volt - 210 amp input (150 amp input at 3000 watt output), modified sine wave inverter (about $1,800)
Three 60 amp charge controllers (about $600)
Thirty six 400 ah, 6 volt, 127 pound batteries connected in series and parallel for 24 v (about $7,700 and 4,572 pounds)
Miscellaneous cables, etc.