ELECTRIC POWER ENGINEERING CENTRE

RENEWABLE ENERGY SYSTEM DESIGN – Sample Exercise

Design a renewable energy system and determine the load, available sunlight, array size, and battery bank size to power a television and DVD player using a photovoltaic (PV) setup, harnessing the power of the sun.

Assume that the television draws 300W of electrical power, and is used 5 hours per day, which equates to 1500 W hours/day, while the 24W DVD player is used 2 hours per day, requiring 48W hours/day of energy (see table below).

Appliance	Power (W)		Hours used/day		Watt-Hours /day (Wh/day)
Television	300	X	5	=	1,500
DVD player	24	X	2	=	48
Total load					1,548

Annually, New Zealand has on average approximately 5.5 hours of sunlight per day.

In addition to the average hours of use, there may be times where the system gets used for 8 hours per day, in which case, you need to allow for extra power usage. Therefore, it is good engineering practice to allow for a bit extra to compensate for this. In this case, assume that you allow for 50% more usage on average i.e. multiply your total Wh/day load by 1.5 to allow for extra 50% usage.

a. Determine energy load required watt-hours (W hours) per day:

1,548 Wh/day x 1.5 = **2,322 Wh/day**

b. determine hours/day of available sunlight at the site (Hours/day):

5.5 Hours/day

c. determine PV array size needed (Watts):

Divide the electrical energy load per day (a.) by the number of available sunlight hours (b.)

2,322 / 5.5 = 422.18 ~ **423 Watts**

d. determine size of battery pack or battery bank needed (Ah) Amp-hour rating:

Experts say that batteries last longer if they only draw down about 20% of their capacity per day, rather than drained completely. This means that in an engineering design, a battery should have the capacity of around 5 times its daily load i.e. 100% / 20% = 5.

This also means that you can store enough power in the batteries to last up to 5 days of continuous use without recharging, in case of cloudy weather. If you wish to design for more days of cloudy weather, multiply by a number greater than 5.

2,322 Wh/days x 5 = 11, 610 Wh or 11.61 kWh

A typical battery voltage is 12V; divide the Wh by 12V to determine Amp-hour rating of the battery bank (note: Power (Watts) = Current (Amp) X Voltage (Volts) or P = V x I, so I = P / V)

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11,610 Wh / 12V = **967.5 Ah (Amp-hours)**

The Design - System Block Diagram

The Inverter: most renewable energy systems are designed to produce DC power. To use DC battery power to run AC appliances, an inverter must change the DC electricity to AC 'household' electricity. Your inverter should produce the correct AC voltage, and have enough output capacity to power all the AC appliances and electrical loads you plan to use simultaneously.

AC (Alternating Current) electricity is the type provided by the local electric company, and is the type most people are familiar with. AC electricity is what operates common household appliances and electric tools. To power AC loads in a renewable energy system, you will need either a generator (which produces AC power) or an inverter (which changes DC power to AC). You can also use an AC power source (like a generator) to power DC loads, if you have an AC to DC 'converter'.

DC (Direct Current) electricity is the type stored by batteries and is what powers your car electrics (e.g. lights, stereo, etc.). DC electrical appliances (e.g. radios) are available from specialist retailers, and often provide better efficiency than their AC counterparts. Most renewable energy systems utilise both AC and DC electricity.