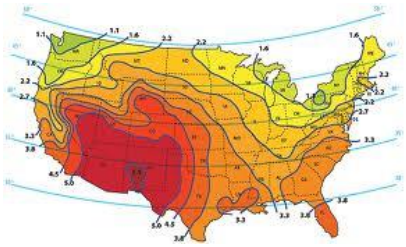
Planning a Solar System

- A few basic components are needed for a solar power system starting with a simple solar cell to more complex systems.
- For starters there are two factors to consider when setting up and sizing a solar system:
  - Amount of Available Direct Sunlight (Solar Insolation)
  - Your Daily Household Power Consumption (Loads)

Sunlight or Solar Insolation



- Insolation = sunlight intensity
- One hour of 100% sunshine on a solar panel = one full sun hour
- In the United States, the average is usually between 4 and 7 hours per day.
- Click on the link below, enter your zip code, and you will find your average hours of direct sunlight per day. NREL (National Renewable Energy Lab)
- All daylight hours are not necessarily full sun hours as the sun in the morning and afternoon has to penetrate through more atmospheric layers .
- Solar panels have more difficulty capturing the suns rays directly during these hours due to the sharper angle of the sun.
- It is important for Solar Panels to face toward the southern sky as the sun will be closer to the equator.
- Some large commercial solar systems use trackers that rotate the panels along with the sun to maximize efficiencies.
- Smaller portable solar panels can be moved during the day to face the sun directly as it moves across the sky in order to capture as much energy as possible.

Tax Incentives

DSIRESOLAR™ Database of State Incentives for Renewables & Efficiency

- *One other important consideration is the amount of Federal, State and Local incentives available for homeowners and businesses to convert to renewable energy sources.*
- *In addition to the 30% Federal Tax Credit Available through 2016, check the DSIRE link for other state and local incentive programs.*

Solar System Components

Solar Panels

- Capture energy from sunlight.
- Solar panels produce DC current.
- Multiple solar panels make up an array.
- The amount of wattage of the panels determines how much energy you can collect.
- A 100-Watt panel, in one full hour of direct sunlight, will collect the equivalent of 100-Watts of electricity.

Power Inverter

- Most household appliances use AC current.
- A power inverter converts Solar DC current into AC current.
- Note that some portable appliances use DC current. (Often for RV use)
- Inverters come in various shapes and sizes from micro to utility-size.

Batteries

- If you plan to store electricity for use when the sun goes down, a battery is needed.
- Many systems do not use batteries. They generate electricity and use it during the day to supplement electricity from the local utility. This is a grid-tied system.
- Deep-Cycle batteries are used, which means they can be used for extended periods of time and be charged and recharged for years. Sealed Lead Acid, Gel-Cell, AGM batteries are preferred.
- The more battery storage (Amp-Hours) a system has, the longer the system can provide power when there is no sun.

Charge Controller

- Because the amount of energy captured by solar panels can be intense and has extreme variations, a charge controller is needed to make sure that batteries are not overcharged or undercharged.
- Charge controllers 'control the charge' to the battery to optimize efficiency and prolong the life of the battery.
- Note that many inverters have built-in charge controllers. (Usually described as Inverter Chargers)

Power Requirements

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Power Consumption

- Your electric bill will provide average power consumption on a daily and monthly basis.
- You can also determine approximately how many Kilowatt Hours of electricity your household needs on average
  - Kilowatt (kWh) = 1,000 Watts for one hour
  - An average household may use 30 or more kW on a daily basis
  - The Chart below shows electricity consumption for common household appliances.
  - The wattage of the largest appliance will help determine what size inverter to use.
  - Note that these are approximations. For example, power consumed by a refrigerator is affected by how many times it is opened during the day which reduces efficiency.

Appliance	AC	DC	How Many	Wattage Per Hour	Hours Used Per Day	Average Watt Hours / Day
Refrigerator	✓		1	50-100	8-10	800
TV	✓		1	150	4	600
Lights	✓		4	50	4	800
Washer	✓		1	450	1	
Gas Dryer	✓		1	250	1	
Electric Iron	✓		1	1500	0.5	
Dishwasher	✓		1	1500	1	
Hair Dryer	✓		1	1500	0.5	
Microwave	✓		1	750	0.5	
Coffee Pot	✓		1	1200	0.25	
Toaster	✓		1	1200	0.25	
Computer + Monitor	✓		1	150	4	
Laptop	✓		1	100	4	
Total Watt Hours						
System Loss Factor						/ 0.8
Adjusted Total						

To Calculate Total Wattage Requirements:

- *Add up the Total Watt Hours Used Per Day Above.*
- *Divide the total by 0.8 System Loss Factor to compensate for normal inefficiencies in solar systems and batteries.*

System Sizing

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Determining the Size of the Solar Array

	Determining Solar Panels Needed	Example	Winter	Yearly Average
1.	Daily Solar Insolation (From NREL Map)	4 Hours		
2.	Power Consumption (Insert your estimate from previous chart)	20 kW		
3.	Number of Watt Hours Needed (Divide Line 2 by Line 1)	5 kWh		
4.	Actual Wattage of Solar Panels (This will vary by size and space available)	200 (.2kW)		
5.	Number of Solar Panels Required (Divide Line 3 by Line 4) (Round Up)	25		

Note: *You may need to factor in that in some regions, during winter there may be half as much sun available so twice as many panels may be required to maintain the same power output.*

Battery Sizing

Note: *A battery bank is only required if you plan to store electricity for use when there is no sun available, or for emergency usage such as power outages.*

	Determining Size of Battery Bank			
1.	Total KiloWatt Hours Per Day			
2.	Determine Days of Storage Required (Expected number of consecutive cloudy days)			
3.	Multiply Line 1 by Line 2			
4.	Battery Depth of Discharge (50% common) Divide Line 3 by 50% (How much power is used before recharging)			
5.	For Low Temperature Regions De-Rate batteries (Multiply Line 4 x 1.2)			
6.	Determine Watt Hour Capacity of Selected Battery (Voltage x Amp Hour Capacity)			
7.	Number of Batteries Required (Divide Line 5 by Line 6)			