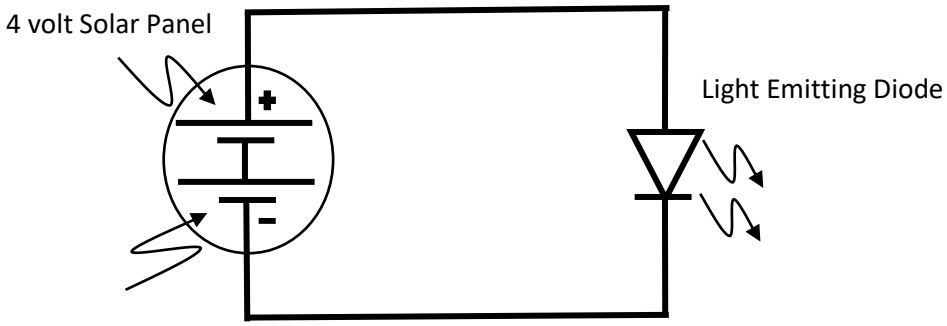
Sustainability: Basic Concepts of Solar Powered Light Circuits

CSL LABORATORIES

Solar Panel to Load - Direct Connection:

The easiest way to use power from a solar panel is to connect the load, for example a Light Emitting diode (LED), directly to the output leads of the solar panel.



Here is an example of this in real life:

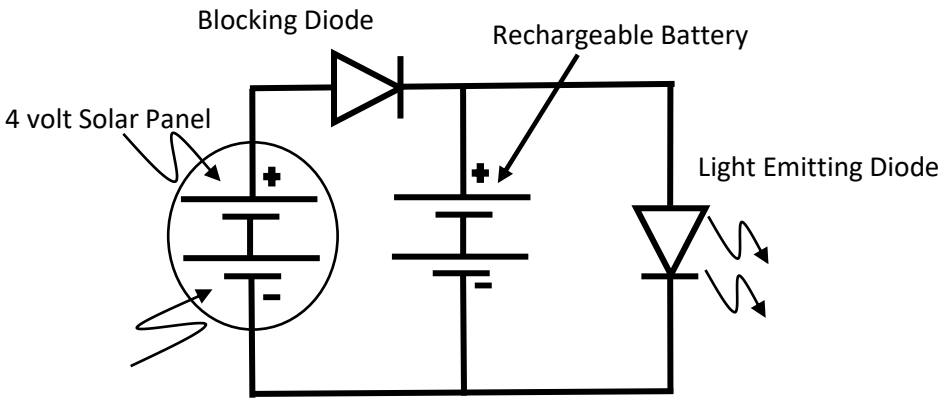
In the above picture, we have connected one of the panels directly to 2 LEDs, yellow and red. Be careful about the current rating of the solar panel and the LEDs. A “regular” LED designed for 20 mA can be destroyed by the current produced by the solar panel.

Interruption-resistant direct connection:

The “direct connection” circuits will work well for their targeted function but are very basic applications. They provide no energy storage, and does not work when there is no sunlight.

Adding a rechargeable battery:

A rechargeable battery will provide a continuous output voltage/power. In this next circuit, we use the solar panel to charge a NiMH rechargeable battery and also light an LED, which will stay on when it gets dark outside.



In the circuit diagram shown above, the solar panel charges a 2-cell NiMH battery (2.4 V). Between the two is a “blocking” diode. This one-way device allows current to flow from the solar panel to the battery, but does not allow current to flow backwards out of the battery through the solar panel - because the small solar panel can sink up to 50 mA in the reverse direction and drain the battery when there is no light. We are using a 1N914 diode for blocking reverse current through the solar panel.

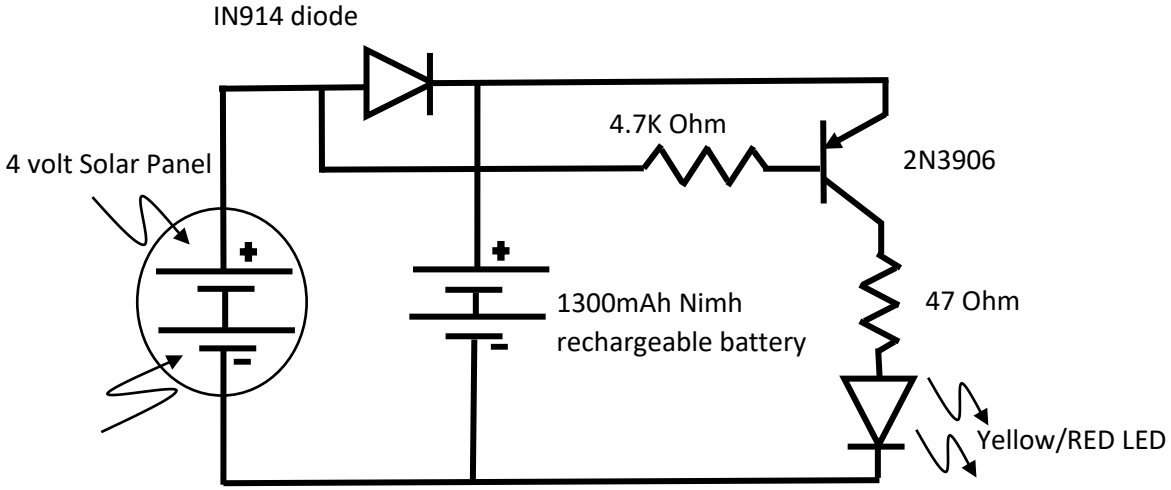
We are “trickle charging” the battery when sunlight is present. For NiMH batteries it is generally safe to “trickle” charge them by circulating through them current following rule of thumb, at a rate below “C/10”. For 1300 mAh battery cells, C/10 is 130 mA, so we keep our charging current below 130 mA – this is perfect since our solar panel only sources up to 80 mA.

The other thing to notice about this circuit is that, the LED is on all the time. The circuit in bright sunlight will waste energy by keeping the LED on: Most of the solar panel

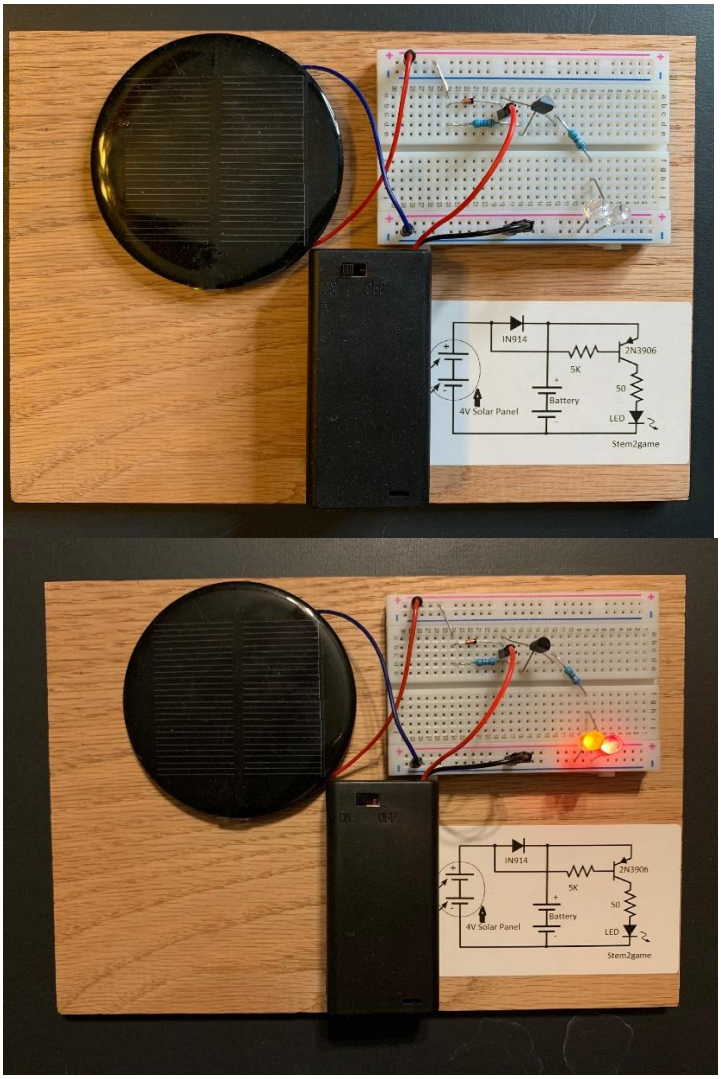
current goes to driving the LED, not to charge the battery. We don't need the LED to glow when there is light - meaning, it should glow only when it is dark.

Detection of Darkness:

We need to add a darkness detecting capability to our solar circuit. Because a solar panel produces a voltage during daylight, it can directly serve as a sensor to tell when it's dark and we can build a darkness detecting circuit based on it.



To perform the switching, we use a PNP transistor that is controlled by the voltage output from the solar panel. When it's sunny or there is enough light, the output of the panel is high, which turns off the transistor, but when it gets dark, the transistor lets current flow to our yellow/RED LED. This circuit works very well and is entertaining for students to learn the concepts.



In the first picture, when there is enough light falling on the solar panel, LEDs are not glowing but instead the batteries are getting charged. This happens because the voltage generated in the solar panel due to the intensity of the light is switching off the PNP transistor 2N3906 and current can not flow through the LED. In the second picture when the light intensity is reduced, the LEDs start glowing because the PNP transistor 2N3906 switches on and current starts flowing through the LEDs.