The Direct Solar Fan

Created, Posted: **June 12, 2008**
Updated: **October 2, 2008**

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1: Introduction:

This Renewable You-able describes the plans and expectations for a direct solar powered fan. The system is designed to provide air circulation via a DC driven fan when the sun is shining, and not provide air circulation when the sun is not shining. The inspiration for this plan: I live in a sunny buy mostly cool area. However, during the summer my apartment is HOT when the sun is out, but COOL when the sun is not out. Therefore, a directly drive solar fan seemed like a great idea to keep air moving through my apartment when it is needed most.

2: Goal:

Provide the design for a system which powers a DC fan directly from a flat solar panel.

3: Starting point:

First, I needed to find or build a fan which suited my needs. I tried looking for components to build my own until I stumbled upon [1]. Creative Energy Technology like many other "solar" supply stores sells an array of DC appliances for use in off-grid solar powered homes and RVs. DC appliances are generally more efficient than AC because most AC appliances convert grid electricity back to DC within the appliance for use in appliance motors, circuitry, ect. Just take a look at any appliance power supply (cell phones, laptops, ect.) and you will see specs on the supply for AC in and DC out.

[1] sells an 8" fan in about the size I was looking for (Figure 3.1). The given power specs say the fan takes 12V DC input and on high pulls 1.3 A. A little math can now help in deciding what size PV panel would work for this fan.

Figure 3.1: The 15W fan from reference [1].

The fan in [1] is designed to use with a battery, which is a constant voltage, current varying device. Basically, a 12V battery will provide 12V at a wide range of currents depending on the load (fan). For example, this fan wants a 12V input and will pull 1.3A of current from the battery when the fan blades are uninhibited. Using Ohm's law

(V=IR) we know the effective resistance of the fan on "high" speed is then R = V/I = 12/1.3 = 9.23 Ohms.

Unlike a battery, a solar panel is a current generating device. As the panel sees more sunlight, the number of photons absorbed increases and therefore increases the device photocurrent, or the current generated from the panel. This means the operating voltage of the device changes depending on the effective resistance of the load and the amount of generated photocurrent. This sounds strange at first, but after we pick a suitable solar panel it will make more sense.

Knowing that the maximum power needed to operate the fan was 15W (V*I), the solar panel needed for operation was going to be rated for around 20W. A rule of thumb, silicon solar panels are generally rated for a power higher than they produce, so getting one with a higher wattage than your load is a good idea.

Using [2], I found a 20W rated flat panel as seen in Figure 3.2. The reference also included the IV (or current / voltage profile) curve for the panel, which was a great help in showing that this is indeed the right panel for the application. The IV curve is shown in Figure 3.3.

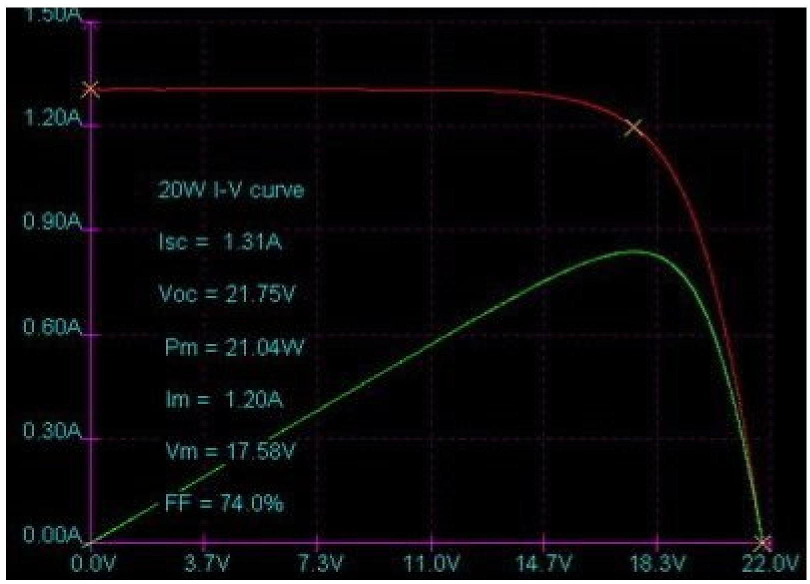

Figure 3.2: 20W rated Solar panel from [2]. **Figure 3.3:** The IV curve for this panel

From Figure 3.3 we can see that this panel, under its best performance, provides 1.3A of current for a range of 0-15V range. So to make sure this panel is right for this application, we can again use Ohm's Law. It is known from before that the effective resistance of the fan is 9.23 Ohms. Therefore, the panel will generate 1.3A maximum, so V=I*R, V = 1.3*9.23 = 12V. A perfect fit.

So one may be wondering, "What happens when the sunlight is less intense, or barely there at all?" Again, we can turn to Ohm's law. Since a solar panel is a current generating device, lets assume it is only receiving enough sunlight to generate 0.8A. Since V = IR, V = 0.8* 9.23 = 7.34V. When an electric motor, like that in the fan, sees a lower voltage, it rotates slower. So the result of less sunlight is a slower fan. This is exactly the result we want because as the sun goes down, we want the fan to stop cooling, as stated in the goal of this project.

This analysis may not be completely correct, because it assumes the effective resistance of the fan does not change with operating motor voltage. One way to be sure this assumption is safe is to operate the fan under a range of known voltages and then measure the current with a multimeter. If the IV line of this experiment is linear, or at relatively a constant slope, then the effective resistance does not change with motor voltage. I do not know that this is a safe assumption, so this will have to be tested in the Construction portion of this project.

4: Construction

The system diagram for this design can be seen in Figure 4.1.

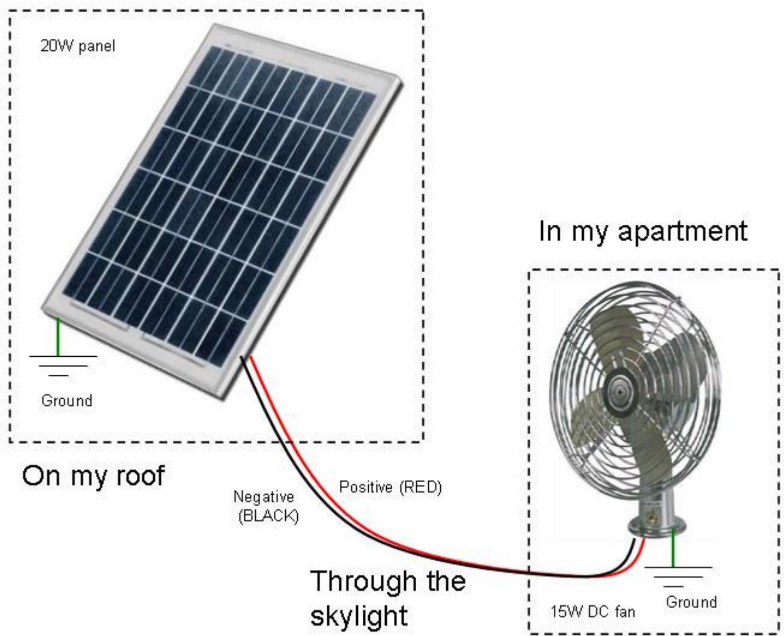

Figure 4.1: The system diagram for this project.

Currently this project is in the planning stages. There is no schedule for completion of this project within the foreseeable future. Depending on the progress of other projects, this one will hopefully be completed by the end of the summer, 2008. Anticipated costs have been outlined in Table 4.1 below.

Part Name	Part Cost	Source	Notes
12V, 15W DC fan	$25.94	[2]	Shipping not included
20W c-Si panel	$140.00	[1]	Shipping not included
Wiring, ect.	$29.00	Home Depot	Estimated
Total	**$194.94**		

Table 4.1: Anticipated build costs.

5: Expected results

Expected performance has been more or less outlined in the Starting Point section of this project.

We can however estimate the payback period for a system like this. Let us assume that a similar fan using AC power would use 40W off the grid (an assumption which needs evaluation). Let us also assume the fan only functions for 1/3 of a year, or 120 days, at 6 hours a day. Therefore the total annual energy usage for this fan would be 28,800 Whrs, or 28.8kWhrs. At an estimated grid electricity price of $0.30 per kWhr, the fan would cost $8.64 a year to operate. That means the cost of the project would be recovered in 169/8.64 = 19.5 years!

Luckily I am doing this to avoid buying a small air conditioning unit, which would use far more energy than a fan of this size. This will make the payback period smaller, however, I am not doing this for payback to begin with. But it is interesting to look at the numbers.

6: Actual results

Actual results will be analyzed after construction of the project.

7: References:

[1] http://www.cetsolar.com/metalfan.htm
[2] http://www.amazon.com/20-Watt-Solar-Panel-crystalline/dp/B000NP3G08/ref=pd_bbs_sr_1?ie=UTF8&s=hi&qid=1213333770&sr=8-1

