Charging a PEV with Solar Energy

Technical Note #14

EGOVEHICLES INC.

Executive Summary

This note helps explain the basic requirements for battery charging and how two methods of solar charging might be applied to charge the eGO Cycle.

Background

Many consumers who are interested in electric transportation are naturally also interested in other environmentally sensitive practices. Often, people have asked us if and how they might be able to power their electric vehicle with solar power, just the way they might be powering equipment on their boat or in their home. The answer is certainly – you can charger your electric vehicle using solar panels, but it might not be very practical. In this tech note, we will describe how you might charger your electric scooter from the sun.

Introduction

First, lets consider how much energy you will need to charger your vehicle. We will use the eGO Cycle 2 as an example. The eGO has two 24V 34Ah batteries. During a normal full discharge, a rider will actually use an average of 22Ah. The total energy used is then 24 V (Volts) times 22 Ah (Amp Hours) or 528 Wh (Watt Hours.) This is the amount of energy that must be added back to the batteries to charge them.

Solar Charging Method 1: 'Solar Home' System

There are two ways you can charge the eGO batteries. The first way is to use the existing AC charger. For this method, you need to plug it into 120V AC power (just like the power from the outlet in a normal home or building. Note that in Europe and other parts of the world, the standard voltage is 230-240V.) This would be the same way you would charger the vehicle using a normal outlet. Some large solar power systems (like those installed in homes designed for operating 'off the grid') include an 'inverter' to convert the DC output of a solar sell or storage battery bank to typical 120V AC power. You then use this AC power to charge the vehicle normally. Actually – when you use AC power as described above, the eGO's battery charger converts (rectifies) the 120V AC power to 28V DC power to charge the batteries.

In this first charging method, the energy flow loose like this:

Sun → Solar Cells (? V) DC → Inverter 120V AC → Charger 24V DC → Batteries.

This is not a very efficient process (there are losses at each step) but it is convenient and fast because it relies on the fact that there is a lot of power available to run the charger and the smart charger can operate at its fully capacity to charge the batteries in about 5 or so hours.

It is important to point out that the energy to charge the batteries for the eGO Cycle must be provided at 24V DC (Direct Current.) Actually a little higher than that, say around 27.8V, because a 24V battery isn't actually 24V, it actually is charged at around 27.2 to 29 Volts. The industry has used '12V' and '24V' because they are just round numbers.

Solar Charging Method 2: Dedicated Solar Charging System

The second way to charge the eGO batteries is to charge them directly with DC power and avoid having to convert the DC power from the solar cells to AC and then back to DC again before it goes into the batteries.

To do this you must have a cell or series of cells that produce power at around 28V DC. You can then connect the output of this 28V DC source directly to the eGO battery system. Alternatively – if your solar cell produces only 14V DC, you must add some 'step up' electronics to increase the output voltage to the required 28V DC before connecting it to the battery system. Be sure to maintain proper polarity when connecting.

In the second charging method, the energy flow looks like this:

Sun → Solar Cells 28V DC → Batteries.

This process is much more direct, and simple, however, it is not as effective as the first method, and depending upon the acceptable recharge time, it might not be very practical.

There are two shortcomings of this approach. The first is that the battery charging is not managed by the 'smart' onboard (AC) battery charger, so the charging voltages and currents are not optimized to speed the charging process and provide safety from overcharging. The second shortcoming is the substantial investment in solar cells required to provide an acceptable recharge time.

The final analysis

Solar cells produce around 0.05Watts per square inch. When converted to a 6 hour day (about as much useful solar radiation you will have in an average day) you will have 0.05W * 6 hours or 0.3Wh per day per square inch. To charge the eGO batteries, you will need about 528Wh. From these two numbers you can determine how big a cell or how long it will take to charge the eGO batteries from the sun. The last item of importance is cost. Solar cells in appropriate sizes will cost approximately $0.90 / square inch.

See this table to estimate the size and cost of a solar cell array that might work for you. Keep in mind that this table does not consider any special electronics or assembly required to produce at 28V output array.

Performance	Size sq ft.	Cost
One Day Charger	12.2	$1,584.00
Two Day Charger	6.1	$792.00
Three Day Charger	4	$528.30

Building a dedicated charger for an eGO Cycle is certainly a commitment, but for some applications may be a perfect solution for 'grid free' transportation.

Perhaps a useful and certainly more economic use of solar energy is to create a solar 'maintenance' charger for your vehicle. The purpose of such a charger is not to bring the batteries up from a low state of charge, but only to maintain a full charge if the vehicle is to be left alone for a long time. Maintenance charging is particularly useful for those who leave their vehicles for an extended period of time and may not wish to leave them connected to an outlet.

A 'maintenance' charger (output of 27.5V) would need to provide only 10Whrs of energy and would measure around 6" x 6" and could cost less than $50. Contact a solar cell provider to determine the proper cell configuration for a small sized 27.5V output array.

Related reading

Additional information about solar technology can be found here
http://science.howstuffworks.com/solar-cell.htm and
http://www.solarserver.de/wissen/photovoltaik-e.html

There are also many internet suppliers of solar cells and related equipment, such as: http://store.sundancesolar.com/ and
http://www.siliconsolar.com/solar_panels.htm