Sizing a Solar Power Supply for a Remote eosFD Installation

Introduction

Automated measurements of soil CO_2 flux are usually limited to field sites with grid or generator-based power infrastructure because of the non-trivial power required to drive the opening and closing motions of automated chambers.

Eosense's eosFD is a new class of soil gas flux measurement devices that uses the patented Forced Diffusion technique. Featuring an integrated CO_2 sensor and datalogger, 1.6 kg weight, and less than 2 W average power consumption, its standalone design delivers spatial freedom at any scale

In this application note we will size a solar and battery power system for a year-round eosFD deployment in Dartmouth, Nova Scotia, Canada. By following the example calculations in this application note, researchers can estimate the power system size required to deploy the eosFD at their remote field sites.

Figure 1. The eosFD is a low-power system for measuring soil CO_2 flux in harsh or remote conditions.

Load Requirements

The first step is determining the power requirements (i.e. the Load). The eosFD has an average power consumption of 1.2 W at 12 V for the default configuration (10 minute flux measurement frequency). Since the eosFD has its own built-in data logger capability, this is the entire load for the system. Multiplying the load by 24 h gives the average daily power consumption in Watt hours (Wh).

eosFD CO_2 flux sensor	
Average power:	1.2 W
Average daily energy consumption:	1.2 W × 24 hours
	= 28.8 Wh

Load Calculation

Battery

We chose an absorbed glass mat (AGM) battery due to the cost, availability and ease-of-use. To calculate the Ampere hours (Ah) needed, take the average daily energy consumption calculated earlier and multiply by the number of days of autonomy you would like the system to have (in this case, we are allowing for up to 5 days of complete cloud cover). After derating for inefficiency, temperature and maximum 50% discharge, we calculate that we need a capacity of 29.3 Ah. Rounding up to the nearest available AGM battery gives us a 35 Ah model.

Average daily energy consumption:	28.8 Wh
Multiply by 5 days autonomy:	28.8 Wh × 5 = 144 Wh
Maximum 50% discharge:	144 Wh × 2 = 288 Wh
10% derating for inefficiency:	288 Wh × 1.10 = 316.8 Wh
Temperature derating @ +10°C:	316.8 Wh × 1.11
	= 351.65 Wh
Divide by 12 V:	351.65 Wh ÷ 12 V
	= 29.3 Ah

Battery Capacity Calculation

Solar Panel Angle

For this example deployment, we chose the Eosense parking lot as the location (44.661° N, 63.542° E) and one year as the duration of the deployment. This makes winter solstice (December 22) the worst case for solar input during the deployment, so we will design for that day. Using the date and latitude, we calculate an ideal angle for the solar panel of 22.16° from vertical.

Ideal angle (A) = L - (23.45° × sin(T ÷ 365.25 × 360°))

Where: Latitude (L) = 44.6667° N

Days from spring equinox (T) = 276 days

A = 44.661° - (23.45° × sin(276 ÷ 365.25 × 360°))

A = 44.661° - (23.45° × sin(276.03))

A = 44.661° - 22.503°

A = **22.16°**

Solar Panel Angle Calculation

Sizing the Solar Panel

As this will be a small system, we can size the solar panel using the simple calculator on the EcoWho website:

http://www.ecowho.com/tools/solar_power_calculator.php

After entering the latitude and starting with a 50 W panel, we find it produces 84.27 Wh on the worst day of the year. Since we only need 28.8 Wh (from the Load calculation) we can try some smaller panels. After a little experimenting with standard panel sizes we find that 10 W is too small (16.85 Wh), 20 W is just barely enough (33.70 Wh) and 30 W is plenty (50.54 Wh).

Time of Year	1
Winter Worst Peak Sun Hours 1.68	50.54 w
Summer Best Peak Sun Hours 5.00	0.15 Kw
Year round average Peak Sun Hours 3.34	0.10 Kw
Peak Amps at 12v	9.62 A
System Amp rating at 12v	1.92 A
Peak Amps at 24v	4.81 A
System Amp rating at 24v	0.96 A

Figure 2. EcoWho table selection showing the Winter Worst power production for one 30 W solar panel in Dartmouth, Nova Scotia.

Selecting a Solar Charge Controller

Since solar panels output varying voltage levels depending on sunlight intensity, a device called a Charge Controller (sometimes referred to as a regulator) is required to regulate the voltage and prevent over-charging the batteries as well as preventing reverse voltage (so power doesn't flow out of the batteries and into the solar panels at night). Ensure that the controller is designed to work with the type of batteries chosen, as different battery types have different charging profiles.

Charge controllers are rated by current and voltage. For all systems, the nominal battery output voltage should match the voltage of your battery (typically 12 V for small installations). The continuous use input current rating of the controller should be greater than or equal to the short circuit current of the panel multiplied by a 1.25 safety factor. If the current rating of the controller is not specified for continuous use, then use a safety factor of 1.56 instead.

The 30 W panel we have picked for this example has an open-circuit voltage of 22.3 V and a short-circuit current of 1.82 A. A little comparison shopping finds a charge controller with 30 V maximum solar input voltage and 6 A maximum solar current, which is well above the safety factor of 1.25 times the panel short-circuit current. The controller also works with both flooded and sealed 12 V batteries and has some nice options like low voltage disconnect and transient surge protection.

Conclusions

For our eosFD installation in Dartmouth, Nova Scotia, Canada we have chosen to go with a 12 V, 35 Ah AGM battery which will give us enough power for 5 days of continuous use with no sun. To keep the battery topped up we're using a 30 W solar panel which we will mount at about 22 degrees (from vertical) and allow the panel to charge the battery via the 30 V, 6 A maximum solar charge controller.

After putting the system in a vented, weather-proof enclosure, we now have a power supply that should keep the eosFD running continuously, year-round in a remote location.

We hope the calculations presented here help you with sizing your solar requirements for your field site. If you would like more in depth review of sizing solar power for field studies please have a look at our blog article:

www.eosense.com/blog/sizing-solar-power-offgrid-studies-1/

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