Solar PV System Sizing for Charging (a school full of) OLPC XOs

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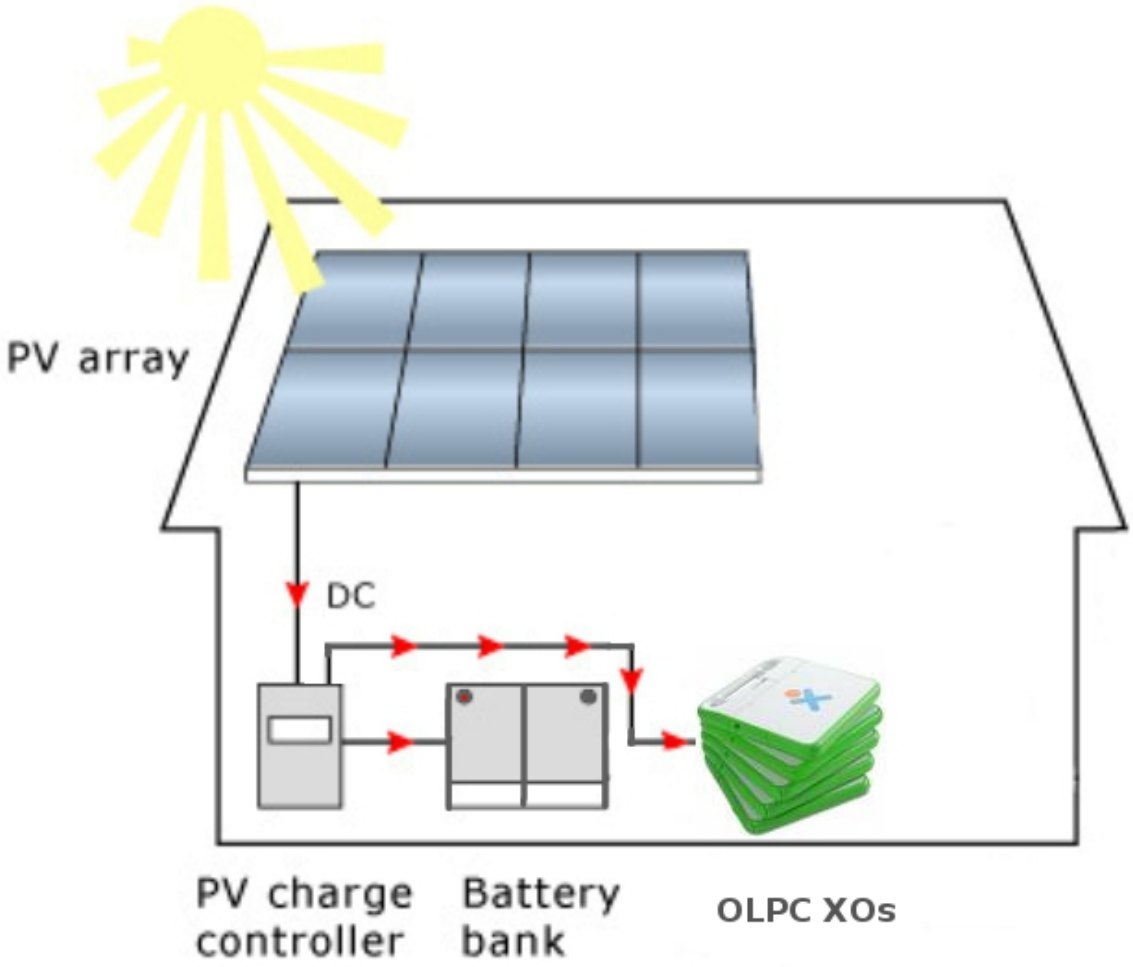


As the OLPC XOs have begun to gain acceptance and use in developing world regions, the easiest deployments have been schools with existing grid electric power. The poorest and most remote schools, which are the majority, are not connected to the electrical power grid. These schools in most cases have been left behind even further, no electric power, no laptops. The low cost capital solution has been to provide the schools with a small fossil (gasoline or diesel) fuel powered generator. As most schools soon realize; the fuel cost, noise, and pollution makes this approach unfeasible and unsustainable.

Solar PV power is the logical long-term solution, as it has a long life, no pollution, or noise. The high up front cost to purchase and install this solution is the big hurdle for these schools. The other issue is the traditional sizing and equipment used. These schools, which previously had no electrical power, often find it tempting to utilize the

panels for powering things in addition to the laptops, such as lighting, TV, air conditioning, etc. Yet doing this may cause expenses to double or triple, and maintenance becomes far more complicated as Direct Current (DC) to Alternating Current (AC) invertors are added.

A Simpler Approach

The approach advocated here is sizing and setting up a solar PV system only to charge and power the OLPC XO laptops. This simplifies the equipment required and keeps the cost to an affordable level for the schools. This approach keeps the system DC only and without the DC to AC inverter, prevents energy diversion from the laptops charging.

Testing the XO

The starting point in any solar PV sizing and system design is: What is the load of the device(s) being powered? Specific to our case is the OLPC XO laptops. Several tests were conducted to measure the charge rate and time of single and multiple XOs. The tests were conducted using the Kill-A-Watt P4400 through the XO AC charger and Eagle System Data recorder eLogger V4 directly DC. The results of this test are that the age of the XO and the amount of usage varied the charging power needed.

Age	Watts	Time (hr)
New	12	1.18
6 months – light use	14	1.20
1 year – daily use	17	1.5

Additional testing was held with students from San Jose State University, San Francisco State University, and the San Francisco OLPC users group on 24 XO laptops. The tests yielded similar results.

In schools, the XO laptops will be used on a regular daily schedule. Thus the 17 watts at 1.5 hours charging time will be used for our solar sizing and design.

Assumptions

We will size and design our XO charging solar PV solution with the following assumptions:

1. 350 XO laptops will be charged after daily usage
2. One recharge per day
3. XOs will be running off their internal battery in the class room (2 to 3 hours)
4. The system will be Direct Current only, no DC/AC inverters
5. The wiring and connections will support only the XO laptop power connections, no other electrical devices.
6. The Solar Panel output is 12v-24v.

The Sizing Calculations

The XO laptop needs 17 watts (at 12 volts) of electricity for 1.5 hours to fully charge a full discharged XO;

THEREFORE 17 watts x 1.5 hours = **25.5 watt hours per OLPC XO**

For 350 XO laptops;

350 XO's x 25.5 watt hrs = **8,925 watt hrs**

Assuming the average month at 5.25 hours (in Haiti) of direct sunlight, the size of the solar panel would be;

8,925 watt hr / 5.25 hours = **1700 watts from solar panels each day**

The battery(ies) required to charge the 12 volt XO laptops would be,

8,925 watt hr / 12 volts = **744 amp-hr**

70% usage factor on the battery and the systems requires,

744 amp hr /0.70 = **1062 amp-hrs battery(ies) required**

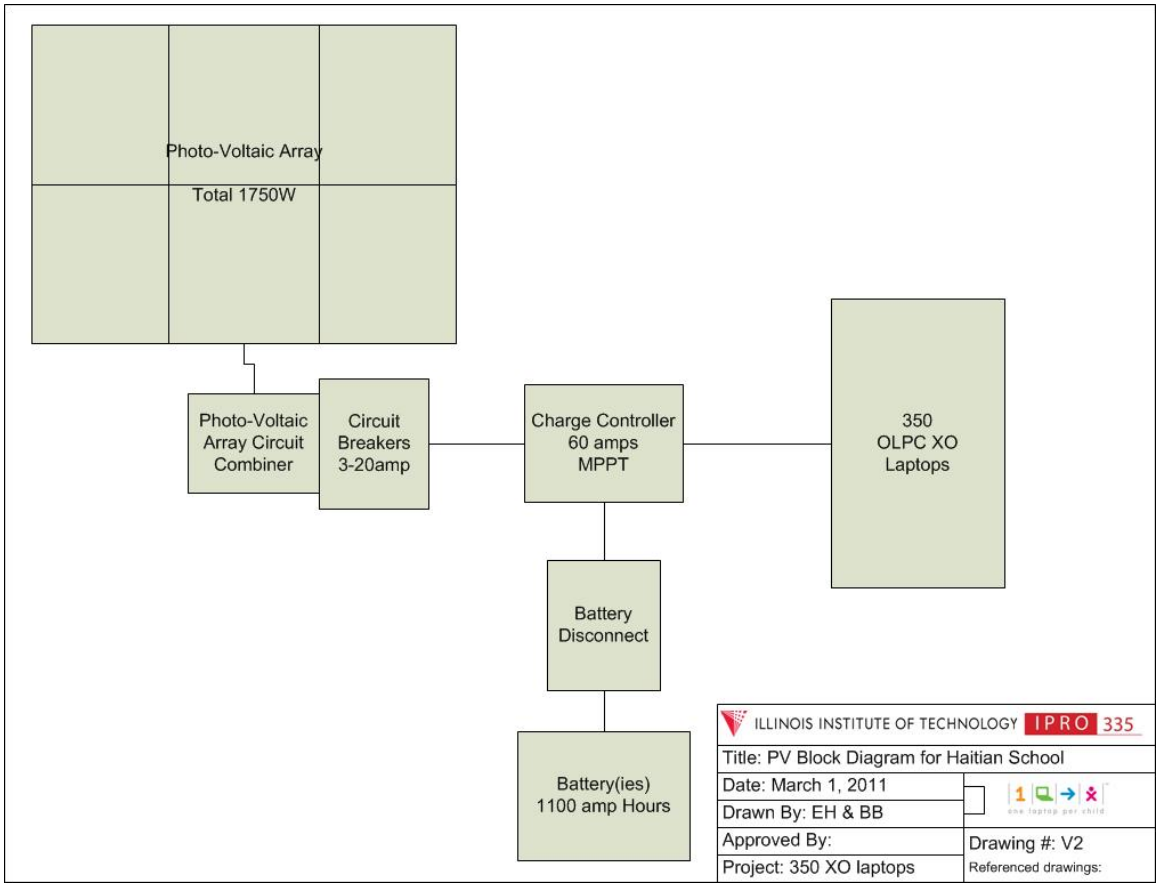
With these basic calculations, we can now design a solar PV charging system for 350 XO laptops: using 8,925 watts of solar energy and 1062 amp-hrs batteries. We will also round up these sizes to industry standard solar PV panel wattage and battery sizes.

System Components

The whole system will contain the following components:

1. Solar PV Panels
2. Box where wire leads from solar PV connect
3. Circuit breakers to protect wiring, batteries, XOs, and prevent fire
4. Charge Controller to regulate energy from solar PV panel to batteries
5. Batteries to store energy
6. Connectors to the laptops

System Diagram



System Costs

The system cost priced here in the US is $9421.50 or about $27 per laptop. Here is a break down of these system component costs:

Item	Size	Number	Manufacturer	Model	Price per unit	Total (USD)
Solar PV Panel	205 watts	9	Kyocera	KD205GX	598.00	5382.00
Circuit Box	600VDC	1	Midnite Solar	MNPV-3	71.00	71.00
Circuit breakers	20amp	3	Midnite Solar	MNEPV15	12.00	36.00
Batteries	105 ah	10	Deka	8A31DT	295.00	2950.00
Charge Controller	60 amp	1	Morningstar	TS-MPPT-60	485.00	485.00
XO power connectors		350			0.65	227.50
Solar PV mount rack			Locally made on site			185.00
Wiring	Various	100 ft				85.00
Total						9421.50