Introducing PV in a Somali Oasis Town

Mark Hankins
and Frank Jackson

Photo by Pamela Collett

Instructor Daniel Kithokoi (left) and student during a hands-on practical. Young women admire their school's new PVs.

Given the relentless violence of the past decade, Somalia's reputation as Africa's basket-case country is almost justified. However, much has happened since the fall of Said Barre and the American Blackhawk debacle of the early 1990s. Peace has come to the northern regions, now called Somaliland and Puntland, and elections in Djibouti are breathing fresh hope for peace in the ragged war-torn regions of the south. With all electricity infrastructure destroyed, and among the best solar resources in the world, many Somalis are committed to using solar energy as a new building block for their infrastructure.

Today, the three nominal regions that make up what was once Somalia (Somaliland, Puntland, and southern Somalia) have no central utilities, very little power generation, and no rural electrification programs to speak of. Energy Alternatives Africa (EAA) and Horn of Africa Relief and Development Organization (Horn Relief, for short) have taken up the challenge to get a solar industry started in the region.

PV Education in Puntland

In July 2000, Energy Alternatives Africa and Horn Relief conducted a basic solar-electric installation course in a Puntland desert oasis community hundreds of miles from the nearest grid. Working with fifteen technicians, we installed six photovoltaic (PV) systems that are now used for lighting and powering school equipment at the Buraan Rural Institute (BRI).

In 1997, Horn Relief sent one of their employees to an EAA Solar Training course at the KARADEA solar training facility in Tanzania. They immediately recognised the potential of solar electricity in Puntland and decided to introduce PV in their area of operation, Sanaag. It took three years to raise funding for equipment and a local training course.

NOVIB, a Dutch development organisation, provided funds for the purchase of PV power systems at BRI. Meanwhile, the British Lotteries and APSO (the Irish aid organisation) provided support to cover the costs of designing systems, running a two-week training course, and overseeing the relatively complicated delivery of equipment from Europe to the Somali outback.

Preparation

In January 2000, Mark Hankins, Fatima Jibrell, and Horn Relief Engineer Omar Irbad visited BRI to map out the school's PV systems and budgets. After this preliminary visit, EAA designed the systems, and Fortum/NAPS was awarded the contract to supply the equipment. In March, Frank Jackson of Green Dragon Energy, Wales, UK was hired through APSO as chief project contractor/electrician.

Shortly thereafter, the course and installation was set for July, and the delivery process was set in motion. In April, a violent hailstorm blew roofs off about half of the buildings at BRI. When we found out about this setback, we decided to use ground mounts for the three multi-module arrays.

Horn Relief organized participation of fifteen technicians in the July courses. Although they work with women as their primary target group, they decided to only involve men in this first course, since women electricians are virtually unknown in Somalia (a future course hopes to train a group of women to install systems in Galkayo, the capital of Puntland).

In early July, Frank Jackson flew from Nairobi, Kenya to Bosasso, to complete the preliminary tasks in the installation, before the course began. The trip involved a six-hour flight in a Beechcraft ten seater, ending up in the spectacular desert airfield, set between arid desert cliffs and Red Sea coral reefs. After spending a night in the heat of Bossaso, Frank and the students made the journey to the oasis town of Buraan, located in the high desert of central Somalia. They were accompanied by AK-47 toting "guards," grim reminders of the security problems of the past. Buraan, in the contested no-mans land between Puntland and Somaliland, has a spectacular scenery of mesas, rock outcrops, and sandy washes lined by green acacia trees. Somali nomads can be seen tending camels and herds of sheep along the rough track that leads to Buraan.

BRI, one of a few higher education institutions in Puntland, is sequestered inside a large walled compound. Outside, there is a town of under 1,000 inhabitants, who draw sustenance from their livestock and a few date palms and fruit trees adjacent to the oasis. The town is surrounded by picturesque yellow-brown cliffs.

Map: Somalia 1992. Courtesy of The General Libraries, The University of Texas at Austin. Disputed borders have been added by *HP*.

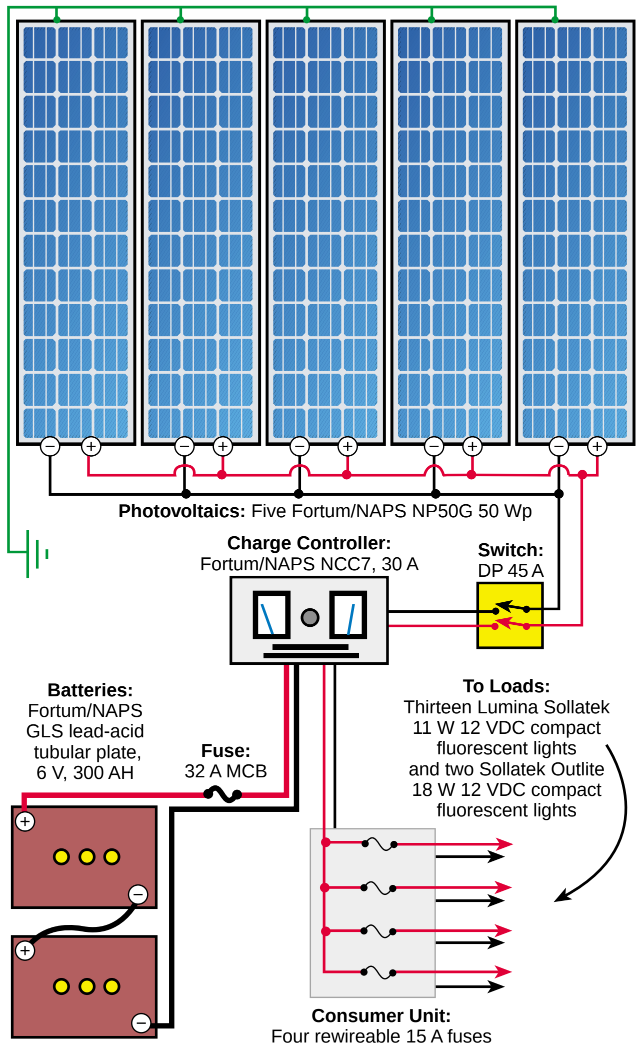
With the help of the fifteen students, Frank unpacked and checked the equipment, began the installation work, setting up some lights and a basic AC power supply, and began holding introductory evening classes for the students.

Given that Somalia has largely been isolated from the rest of the world over the past ten years, it has not been exposed to the "solar revolution." People in rural areas have concentrated on simply surviving and avoiding conflicts. So an entire generation of people is without education and relevant skills. As bright as they are, our students have had little opportunity to access formal education. When Frank began holding introductory classes, he had to start with the basics, from DC electricity to solar energy.

Frank had detailed plans of the installation that he'd drawn up after EAA's preliminary visit earlier in the year. The Buraan school compound is a square-shaped, walled-in area of about 100 by 100 meters (328 x 328 feet), surrounded by a high perimeter wall topped with rolled barbed wire (a grim reminder of more chaotic times).

Running through the centre is a wall that separates about a third of the total area, the girls' quarters, from the rest of the compound. The main area consists of all the other buildings, including the boys' dormitories, classrooms, and teachers' houses. The yellow-painted

System 1: Classroom Block 12 Volt PV System



buildings are made of sturdy concrete/mortar and topped by tin roofs. The school was originally built about twenty-five years ago as a rural training institute, but was abandoned when the government fell apart. Horn Relief has taken it over.

Six PV Systems

The systems at BRI consist of:

- A 250 Wp DC-only lighting system for four classrooms.
- A 250 Wp system to provide AC lights and AC power for the dining hall, library, radio room, and boys dormitory.
- A 150 Wp system providing DC lights and AC power for the guest house.
- Lighting systems for the girls' dormitories—two 50 Wp, and one 20 Wp.

Since so few spare parts are available in Somalia, everything except the battery acid was flown in. We couldn't afford omissions. Frank had sourced student training kits and accessories like nuts, bolts, circuit breakers, and fuses in Wales, and then had them shipped to the Fortum/NAPS corporate office in Finland. They packed Frank's purchases with the modules, inverters, batteries, and regulators, and air-freighted the consignment to Dubai. Horn Relief picked up the shipment there and flew it to Bosasso. We were lucky—everything arrived in working order, and the local battery acid proved acceptable.

A week later, the rest of the training team arrived: Mark and Daniel Kithokoi from Nairobi, and Abdalla Kyezira from Uganda. The job was a big one, and the Somali students had no experience at all with solar-electric systems, hence the need for four trainers. There were fifteen students, all chosen beforehand by Horn Relief. Our trainees included an engineer (Irbad Omar from Horn Relief), several schoolteachers, three businessmen, two technicians, a radio operator, and a mullah (an Islamic clergyman).

Solar Training

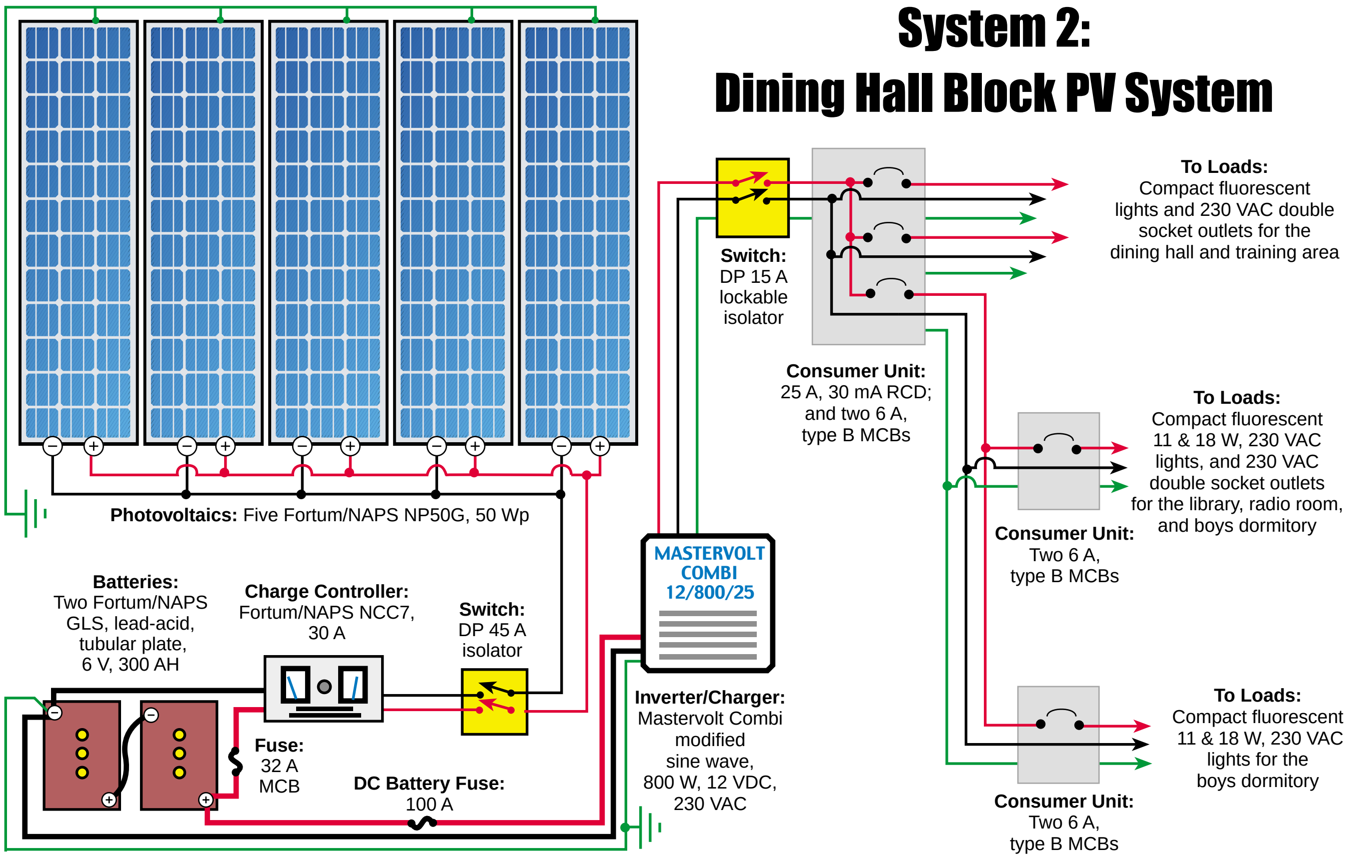
The course lasted ten days, with the theory work done by Mark and Abdalla in the mornings and evenings. After ten years, EAA has PV training courses down to a science. With a full set of detailed lesson plans and resources, we have been training East African instructors like Abdalla, who works for Incafex, a Ugandan solar company.

Daniel managed most of the practicals, and he and Omar oversaw teams of masons who built concrete ground mounts for the three multi-module arrays. Kithokoi also built aluminum roof mounts from extra pieces of ground mount frames.

Frank oversaw the general installation work and did the 240 VAC work in the dining hall, offices, and boys dormitories. Things took longer than expected, since there was much improvisation in the far from ideal working conditions. Still, the enthusiasm of the students was infectious, and ten-hour days were the norm. Classes began early in the morning, followed by prayers, practical work, prayers again, and an evening class in the solar-lit classroom.

For the ten days, students and teachers slept on mats on the ground. Food consisted of spaghetti (the Somali national dish—a legacy from Italian colonialism), delicious white bread rolls baked fresh every day, and meat (mainly goat, but sometimes camel) in spicy cardimom sauce. Tins of tuna fish appeared now and again, and fruit juice and fresh dates provided vitamin C.

System 2: Dining Hall Block PV System



AC Lights & Power

The trickiest installation was the 250 Wp system providing AC lights and AC power for the dining hall, library, two-way radio room, and the boys' dormitories—three buildings in all. It consisted of five ground-mounted Fortum/NAPS NP50G, 50 Wp polycrystalline modules; two GLS 6 V, 300 AH, lead-acid tubular plate batteries; a Fortum/NAPS NCC7 30 A charge controller; and a Mastervolt Combi 12 VDC, 800 W, 230 VAC modified sine wave inverter-charger.

The 230 VAC lights included energy efficient 11 W and 18 W PLs. Frank did most of the 230 VAC wiring himself, since no one else had the wiring skills. The students helped with hoisting and installing the overhead wiring, laying the cables, and installing the accessories (often bashing nasty holes in the soft plaster walls).

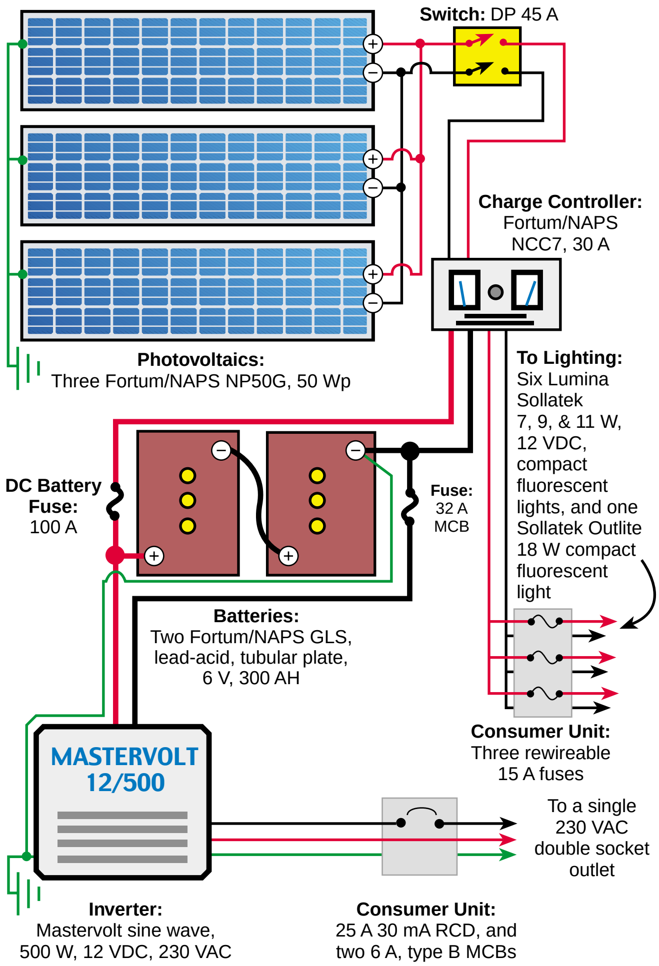
All AC distribution was protected by a residual current device (RCD or earth fault leakage circuit breaker). Each building had its own consumer unit (AC distribution panel) with 6 A circuit breakers, one for lighting circuits and one for outlet circuits. Socket outlets were of the 13 A UK type, and we brought a box of 13 A fused plugs along to fit in them. In total, only five double-socket outlets were installed, since we wanted to be able to control the number and types of appliances plugged in. (The non-adjustable low voltage disconnect on the Mastervolt Combi is only 10 volts, enough to protect the Combi itself but not the battery.) Battery state of charge is indicated by an analogue voltmeter in the NCC7 charge controller.

Distribution between buildings was with UV-resistant cable tied to an overhead stainless steel wire, installed to carry the cables. We decided against connecting the Honda 500 VA petrol generator on site to the inverter-charger, since it would be adding an unnecessary level of complexity.

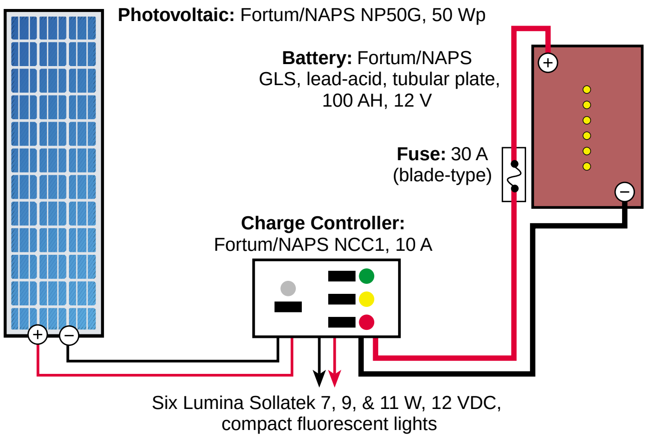
Besides, the output from the solar array at six peak sun hours a day is more than sufficient to provide all the energy needed. If necessary, the distribution system can be extended at a later date. In a remote location like Buraan, a system as complicated as this requires considerable user education, which is one reason why Frank stayed on for an additional two weeks.

The radio operator was to be responsible for maintaining batteries, taking daily readings of battery voltage, and seeing that lights are switched off when not in use. Engineer Irbad Omar was fully briefed on the operation of the systems. It would be his job to make sure basic maintenance was being carried out regularly, to deal with any problems that came up, and to extend any AC wiring if required. Complete wiring diagrams and manuals for equipment were handed over to him.

System 3: Girls' Block Guest House PV System



System 4: Girls' Dorm 1, PV System



Irbad has kept in touch with Frank, since Puntland has recently acquired email facilities.

12 Volt System

The classroom block was powered by a ground-mounted array of five 50 Wp Fortum/NAPS NP50G modules. We used two 6 volt GLS 300 AH, lead-acid, tubular plate batteries wired in series, regulated by a Fortum/NAPS NCC7 30 A charge controller. Each of the four classrooms used three of the 11 W Sollatek PL units. Two Sollatek 18 W "security" lamps provided outside lighting. The security lights were so good that some of the BRI teachers prepared lessons under them, outside in the warm night air.

We used the old type 230 VAC consumer units (AC distribution panels) with rewireable fuses for the distribution circuits. These are no longer available in the UK, and it was only with some difficulty that Frank and Daniel were able to find them in Nairobi. These days, most AC consumer units have 230 VAC rated circuit breakers, but these older units with their rewireable fuses work well for 12 and 24 VDC systems.

These fuses are basically a block containing a strand of fuse wire. If the fuse blows, it is simply replaced with another strand of fuse wire, which is readily available in 5, 15, and 30 amp sizes. The consumer units being used now have circuit breakers that are AC rated, not DC. The rewirable fuses work on 12 and 24 VDC without any problems.

Batteries and charge controller were situated in a central classroom that is going to be the BRI science lab. Solar electricity will be part of the curriculum (the head teacher attended all of the classes), and the NCC7 charge controller is a nice teaching tool. A flick of the switch and students can see charging current and current to loads in a clear analogue display. It's important when putting solar-electric systems into educational establishments that students are able to see how they work and gain some understanding of the technology, especially in Africa where solar is making great strides.

In all of the systems, the ground mounts were some distance away from the batteries. We had to double and treble-up on cables. The largest size we had or could find was 6 mm^2 (slightly larger than #10), but in all cases we got under 5 percent voltage drop. Although we considered the idea of making the system 24 VDC, we settled on 12 VDC to make it easier to find spare light fixtures, since all of the other systems are 12 VDC.

Guest House PV System

The third system was the 150 Wp system providing DC lights and AC power for the guest house. This consisted of another three ground-mounted 50 Wp polycrystalline Fortum/NAPS NP50G modules, two Fortum/NAPS

Buraan Rural Institute Systems Costs

System 1: Classroom Block	*Cost (US$)*
5 Fortum/NAPS NP50G modules, 50 W	$1,025
2 GLS 6/300 tubular plate batt., 6 V, 300 AH	630
Miscellaneous	600
13 Sollatek PL lamps, 11 W	351
3 Sollatek outdoor PL lamps, 18 W	225
Fortum/NAPS NCC7 charge controller, 30 A	198
Support structure	130
2 Sollatek PL lamps, 7 W	54
System 1 Total	$3,213

System 2: Dining Hall Block	
5 Fortum/NAPS NP50G modules, 50 W	$1,025
Mastervolt 12/800 inverter/charger	820
Miscellaneous	700
2 GLS 6/300 tubular plate batt., 6 V, 300 AH	630
Fortum/NAPS NCC7 charge controller, 30 A	198
Support structure	130
20 PL lamps, 240 VAC	160
System 2 Total	$3,663

System 3: Girls Block Guest House	
2 GLS 6/300 tubular plate batt., 6 V, 300 AH	$630
3 Fortum/NAPS NP50G modules, 50 W	615
Mastervolt inverter, 12 V, 500 W	600
Miscellaneous	600
Fortum/NAPS NCC7 charge controller, 30 A	198
Support structure	130
4 Sollatek PL lamps, 7 W	108
2 Sollatek PL lamps, 11 W	54
System 3 Total	$2,935

System 4: Girls Dorm 1	
12/100 GLS tubular plate batt., 12 V, 100 AH	$248
Fortum/NAPS NP50G module, 50 W	205
Miscellaneous	200
4Sollatek PL lamps, 7 W	108
Fortum/NAPS NCC1 charge controller, 10 A	65
2 Sollatek PL lamps, 11 W	54
System 4 Total	$880

System 5: Girls Dorm 2	
Korea lead-acid battery, 12 V, 100 AH	$120
Fortum/NAPS NP50G module, 50 W	205
Miscellaneous	200
4 Sollatek PL lamps, 7 W	108
2 Sollatek PL lamps, 11 W	54
Morningstar charge controller, 10 A (donated)	0
System 5 Total	$687

System 6: Girls Dorm 3	
Rocket lead-acid battery, 12 V, 50 AH	$60
Miscellaneous	100
2 Labcraft 8 W fluorescent & 1 Sollatek CF	81
Fortum/NAPS mini-kit charge controller, 5 A	30
Fortum/NAPS mini-module, 20 W (donated)	0
System 6 Total	$271

Training Materials	
Books	$320
Tools	250
Digital multimeters	230
Training Materials Total	$800
All Systems Total	$12,449

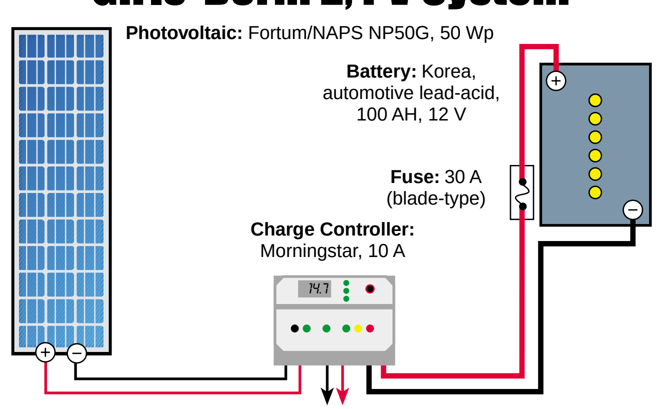
GLS, 6 V, lead-acid, 300 AH, tubular plate batteries, a Fortum/NAPS NCC7 30 A charge regulator, and a Mastervolt 12 VDC, 500 W, 230 VAC sine wave inverter. This system is probably bigger than it needs to be, but the excess power will be useful in the future.

The AC circuits are protected by a 30 mA 25 A RCD. We always install these on inverter systems, but it is not straightforward. Some RCDs will not work with some inverters, and even if they appear to work by tripping when the test button is pressed, you can never be sure if they are tripping within the specified earth leakage current value and specified tripping time.

Three Small PV Systems

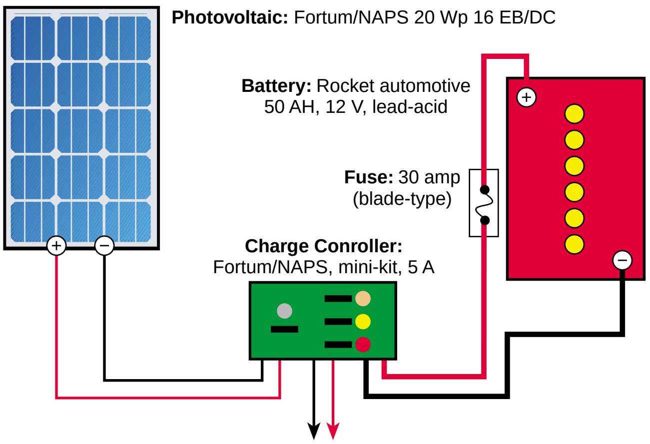
The three small single-module systems, installed in the girls dormitories, were all slightly different. They were installed completely by the students, with EAA trainers

System 5: Girls' Dorm 2, PV System



Five Lumina Sollatek 7, 9, & 11 W, 12 VDC, compact fluorescent lights

System 6: Girls' Dorm 3, PV System



Two Labcraft 8 W fluorescent tubes, and one Sollatek 7W CF

watching closely. Two systems had single roof-mounted 50 Wp polycrystalline Fortum/NAPS NP50G modules. One of these had a 10 A Fortum/NAPS NCC1 charge controller. In another we used a 10 A Morningstar controller, kindly donated to EAA for test purposes. It arrived as a circuit board, and a wooden casing was constructed on site. One of these systems has a 100 AH automotive battery we bought in Bossaso, and the other has a 100 AH GLS lead-acid tubular plate battery.

Each of these systems had five Sollatek lights. The third and smallest system has a 20 Wp polycrystalline Fortum/NAPS module, pole-mounted, with a Fortum/NAPS 5 A charge controller and three lights—one Sollatek and two Labcraft 8 W fluorescent tubes. A locally available 50 AH automotive battery was used.

PV and Education

It was important to our educational mission that the systems were varied. Using different components gave the students an opportunity to see different designs, and using local batteries is probably the way most small solar home systems will be installed in the future in Somalia.

Horn Relief is now marketing some small solar-electric systems in the region. They are convincing local electric shops to supply the proper switches, junction boxes, cables, batteries, and other accessories. They will be using locally available components where possible, while importing solar modules, charge controllers, and lights (and batteries for larger institutional systems).

EAA will continue its training work in the region, holding two more courses in Somalia over the next year. One will be at a school in Hargeisa, the capital of Somaliland, and another (for women only) will be in Galkayo, in Puntland.

A Solar Future for Somalia

After more than a decade of war, the Somalia region is now moving into a season of peace. People are tired of conflict, and the ones we worked with are interested in rebuilding. Somalis are returning from all over the world to settle in their homeland. Others are sending contributions to their families back home.

With little infrastructure remaining, there is a fantastic opportunity for the country to use its ample wind and solar resources as a mainstay for the economy. Instead of running lines from diesel-fired power plants in major towns, many small settlements can economically generate their own power from the sun and wind.

However, for this to happen, a solar infrastructure needs to be built. In Somali towns, everybody knows about petroleum generators, and the sound of generators is heard through the night. Few people know about solar-electric systems, though the interest is there. Everywhere we went in Puntland and Somaliland, people are keen to go solar when they hear about it.

It is the local business and NGO community that will help solar power fill the niche that it can sustainably occupy in Somalia. For this group to gain information about viable solar applications, a strong effort needs to be made to train Somalis. With partners like Horn Relief, EAA continues to help develop the Somali solar infrastructure. Much more needs to be done. Please contact us if you are interested in participating.

Access

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