

A Decade of PV...

Lighting in the Colorado Rockies

Laurie Stone

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Above: The Tenth Mountain Division Hut Association's network of twenty two high mountain lodges offer breathtaking views of the Colorado Rockies like this one of Mt. Massive (14,421 feet) as seen from the Skinner Hut.

Backcountry skiing in the Colorado Rockies is exhilarating and exhausting. There's nothing better after a hard day of skiing through fresh powder than ending up at a mountain hut miles from the nearest town with a wood burning stove, comfortable beds and solar-powered lights.

This might sound like a dream too good to be true. Yet in the mountains between Aspen and Vail there is a system of ski huts called the Tenth Mountain Division Hut Association (TMDHA). The "huts" are actually beautiful mountain lodges with everything you need for a pleasant relaxing night, including PV-powered lights.

The name "10th Mountain" honors the soldiers of the 10th Mountain Division of the US Army. Fifty years ago, at the brink of World War II, the U.S. War Department realized it was necessary to train mountain troops. The troops trained for two years in the Colorado Rockies. By 1945 they were in Italy where they had a crucial role in several battles.

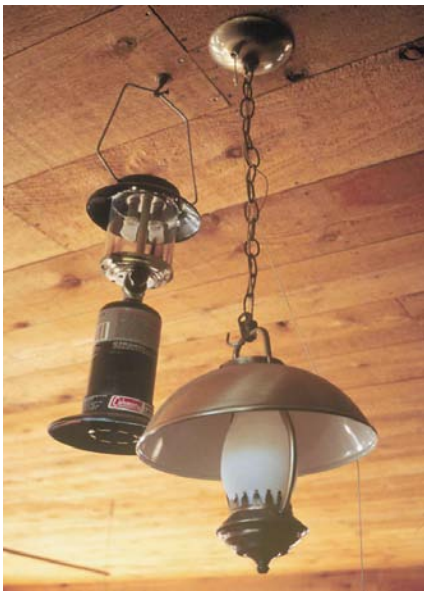
Thanks to these troops, and to some dedicated Colorado skiers, we can say goodbye to the days of cold, winter camping and hauling lots of gear. We now get in all the Telemark turns we want and have a nice warm place to drink a glass of wine at night. There are twenty-two huts in all. Thirteen of them form a loop between Aspen and Vail. The other nine are located south of Aspen and are called the Alfred A. Braun Huts and the Friends Hut.

Why Solar?

TMDHA is a non-profit corporation, formed in the early 1980s, that manages the huts, which are linked together via intermediate ski touring trails. Each hut sleeps from 16 to 20 people, and anyone can make a reservation for the night.

One of the dilemmas from the very beginning was lighting the huts. At the time, TMDHA was spending \$500 a year on fuel for each minimally lit hut. PV-powered lights seemed perfect for the remote cabins. Three professors from the local Colorado Mountain College (CMC) who were teaching classes on solar energy, set out to convince the TMDHA staff that solar was the way to go. That did not prove to be an easy task. The TMDHA Board was interested, but, as with any new technology, there were some reservations and many questions.

One of TMDHA's big considerations was aesthetics. The huts are located in beautiful, pristine mountain settings. Some felt that backcountry skiers would regard the solar electric panels as detracting from the beauty and the rustic feeling of a high country experience. However, there were safety issues to consider. They were presently using volatile fuels for lanterns, along with a large number of candles. The first hut in the Braun Hut system, the Lindley Hut, burned to the ground because of a careless candle user. Environmental considerations also abounded. Hundreds of lantern sized propane tanks were becoming a disposal problem. Safety and the environment won out. The TMDHA staff decided to make a commitment to solar.



Left: The old Kerosene lanterns were replaced with DC compact fluorescents retrofitted into rustic antique style fixtures.



Joe Schwartz, an SEI student, wires the replacement panels for pole mounting at Uncle Bud's Hut.

Requirements and More Requirements

Designing the systems was another story. The huts all experience extreme winter conditions. They are all over 8,000 feet in elevation where the temperature can get as low as 40F below zero. The users of the systems are people who are not trained or knowledgeable about solar electricity. Approximately 21,000 people use the huts each year, usually spending only one or two nights at each hut. Some of them would probably not realize they are using solar powered lighting, or even know what photovoltaics are! So the systems had to be reliable.

Although the solar design advocates didn't want to inconvenience people, they did want to educate them about living with solar. The list of requirements for the systems was getting longer by the minute. Taking everything into account, for the PV systems to be effective, they needed to be reliable, understandable, manageable, educational, convenient, simple, sustainable, and low cost. Not an easy list to fulfill.

Nevertheless, when the systems were first installed in the early eighties, the CMC instructors assembled all of the basic components with these considerations in mind. To keep the systems as simple as possible, they were all 12 Volt DC systems. Inverters were not as dependable then, and reliability was crucial.

We learned a lot of lessons trying to meet all the concerns. However, the growth of the PV industry and



Above: Johnny Weiss and the SEI introductory PV class pose for a "System Completed" photo with the new year-round array at Uncle Bud's Hut.

the evolution of the components, have allowed the systems to be upgraded to answer many of these concerns. The CMC instructors went on to found Solar Energy International (SEI), a non-profit educational organization. SEI, Rocky Mountain Solar Electric, and



Above: The Traditional style of Uncle Bud's Hut integrates perfectly with the natural beauty of the Rocky Mountains. Notice the winter oriented (vertical) array before its replacement with an all-season pole mount system.

SunSense Solar Electric Systems, local PV installers and dealers, have installed systems on all 22 huts that are safe, reliable, understandable, economical, and, most important of all, work well.

An Array of Arrays

We can happily say there have been no module failures over the past decade and a half. The huts all have different modules that are being used in extreme winter conditions. The cold, wind, hail, ice and snow has not posed a problem for a single panel. The systems range from one to six panels, and we have not heard a single complaint about the panels being an eyesore. No one has ever griped about their wilderness experience being marred by high technology. And the huts have seen a lot of hard core back country environmental folk who want a true back country experience.

The huts originally had US Forest Service permits for winter use only. This allowed us to mount the panels vertically on a south wall. The snow reflection and the low winter sun provided a lot of power from the panels. However, now the huts are also being used in the summer. Even though the summer provides us with more and longer sunny days, many systems are not providing enough power because of the higher summer sun angle. Therefore, nearly all of the systems are being retrofitted.

Controls for the Unknowing

If there was one lesson we learned, it is that you can never make a system simple enough for all of the people all of the time. Two main considerations were a

Right: Analog meters and layman's instructions make for a simple and easy to operate PV system.



The original package had three analog meters; battery voltage, array current and load current, all clearly labeled and explained. Analog meters were chosen because flashing digital lights in a remote mountain setting seemed slightly obnoxious. In the early systems, we used an automotive fused DC load center and, for a short time, an automotive light as a warning light. However, we learned the light would go on during LVD, stay on, and drain just enough energy to prevent the battery from being recharged. We quickly changed to less consumptive LED warning lights.

Inside the control boxes we use a variety of factory and field-adjustable controllers, most with temperature compensation. These have all proven reliable throughout the years. Ananda Power Technologies has been helpful in customizing the Power Centers for us. The original Power Centers have labels and meters that the average hut user does not need to understand. We have simplified the center and stayed with the analog meters so that the controls will be understandable to everyone and familiar to past users.



Left: Ananda Power Centers offer expandability in an easy-to-use package. Note the fire extinguisher and emergency flashlight.

Storage for Snowstorms

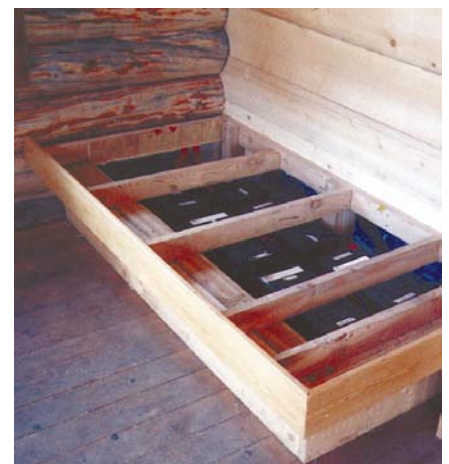
Batteries provided us with yet another challenge. The huts get the heaviest use during periods of least sun and when the batteries are the coldest. This is an inherent mismatch, but not an impossible situation. The battery pack just needed to be sized effectively for the conditions. Most of the systems use lead acid batteries, although there are two systems with nickel cadmiums and nickel irons.

low voltage disconnect (LVD) and a low voltage warning light. A LVD protects the batteries from over discharge. An low voltage warning light forewarns hut users of the impending loss of light, hopefully causing them to be more conservative in their use of the lights. Since we're not able to educate every single skier who is going to stay overnight at the huts, these two components are crucial.

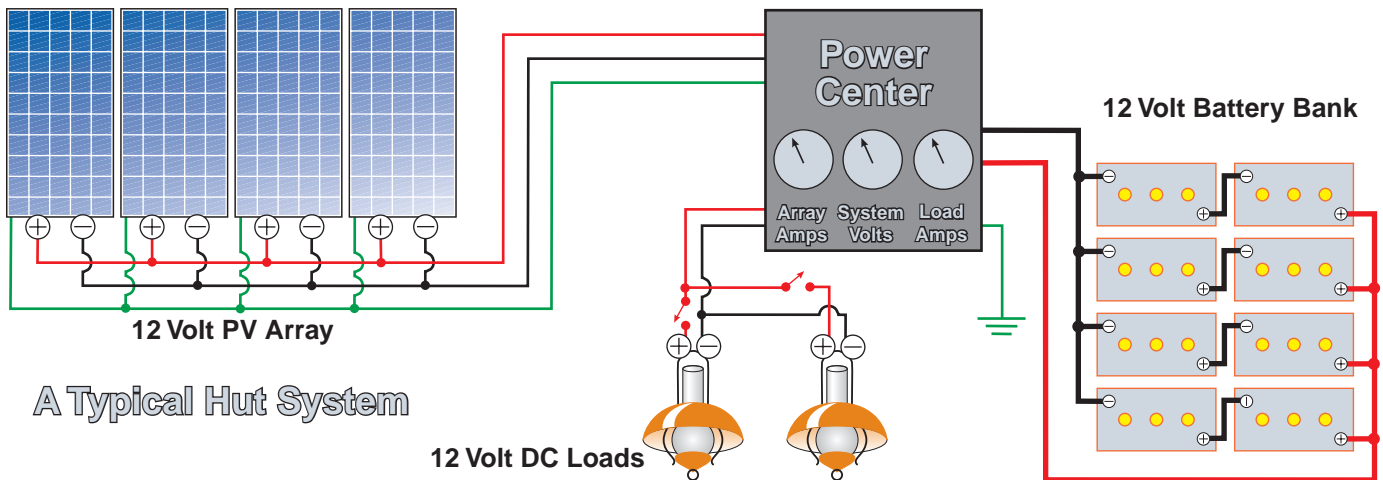
Originally the control/meter package had to be specified and built out of individual components. While this was a great educational opportunity for us (since all but a few of the systems have been installed by our students in PV workshops), it was quite time consuming. Now we use an Ananda Power Center for all the controlling and metering. It gives us many more capabilities than we will ever need for the small systems (for now, at least). TMDHA likes the Power Center too, because it's attractive, UL approved, very expandable and a good step toward our efforts at standardization.

There was also no back-up source for battery charging, except for the occasional very inconvenient generator/battery charger. It is quite doubtful that several systems have ever been properly equalized. This led to the premature need to replace several battery systems. The "don't fix it 'til it's broke" rule doesn't work for batteries! Battery maintenance has

Right: Six Trojan T-105 batteries 660 Amp-hours at 12 Volt in the Gates Hut.



Systems



A Typical Hut System

12 Volt DC Loads

been the responsibility of TMDHA personnel and has been irregular. Keeping the huts useable when tens of thousands of people use them each year is a huge job. The small TMDHA staff have many other things to do besides check batteries. Some huts went years without being checked. Some batteries have been boiled dry while others have been sulfated by insufficient charging. More sophisticated control strategies that allow us to conveniently equalize batteries will hopefully improve battery life.

Lights

The only load the huts have is lighting. Our desire to impress people with how well solar energy can light a cabin caused us to carry the lighting a little too far at first. A few of the remote mountain huts ended up looking somewhat like remote 7-11's. People could definitely see that solar energy worked! However, we eventually replaced the 22 Watt Circle Line fixtures and 13 Watt compact fluorescents with smaller compact fluorescents.

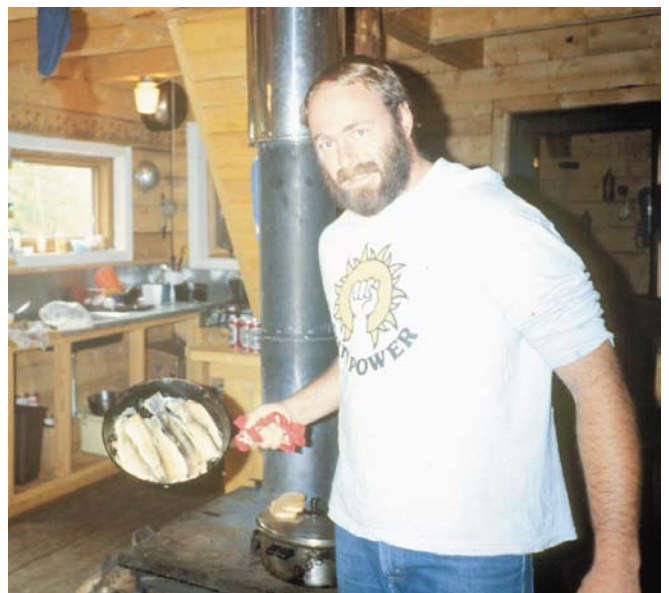
The main lighting consideration was to keep the rustic look. When TMDHA first heard we wanted to put in fluorescent lights they thought it was atrocious. We ended up retrofitting commercial ac, antique style lantern type, fixtures for compact fluorescents. This keeps the rustic look while providing an efficient lighting source.

One of the main questions over the years has been whether or not to change to an inverted 120 vac system. Although some of the 12 Volt DC ballasts have failed and are more expensive than 120 vac ballasts, TMDHA decided to stay with DC. Inverters, as reliable as they are these days, bring one more level of complexity to the system. However, many of the lights are being changed to incandescent 15 Watt DC bulbs to get rid of the ballast altogether.

Servicing the Systems

Monitoring the performance of the systems over a decade and a half has led TMDHA to the conclusion that they need a service contract. They are not solar technicians, or even homeowners who are living with the systems themselves. Although some of the TMDHA staff have been trained in PV maintenance, they have many other things to do. They now feel the solar lights are a valuable part of the hut experience. Now it is worth their while to have a maintenance/service contract to ensure top performance and high reliability.

SEI and SunSense are in the process of providing a maintenance and service contract for the hut's PV systems. It entails two trips a year to each hut to make sure the systems are working properly, tighten the



Above: Steve McCaerney (former CMC Solar Professor) cooking up some dinner at the Estin Hut.

connections, and water and equalize the batteries. Not only does this guarantee that the systems are in top shape for the winter season, but it also allows SEI and SunSense staff to spend a couple nights in a beautiful remote setting in the Rocky Mountains.

The TMDHA hut systems have proven that PV systems can be made reliable and sustainable without constant monitoring. They have also educated tens of thousands of people about solar electricity. And they have made the back country experience of skiers from around the world safer, more environmentally benign, and a lot more comfortable.



Above: Skiing from hut to hut.

Above Right: SEI student Kerry Bell from Willits, CA solar cooking at the Skinner Hut.

Right: Author Laurie Stone enjoys a fresh snow at Margy's Hut.



Systems

Access

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