Utility-Intertied PV Workshop

John Day, Oregon, July, 2000

Richard Perez

There surely must be something more satisfying than putting solar energy on the grid, but I can't think of it. Every time I get to blow a little sunshine up a coal-burning or salmon-killing utility's skirt, I just have to grin.

Solar-electric systems just don't spring up like mushrooms. They require meticulous planning, mucho ground work before the installation, and a crew that knows what to do. This system at the Grant County Fairgrounds was no exception. It took months of work from many folks to bring solar electricity to the Oregon Trail Electric Co-op.

It all began at the end of the 1999 SolWest Fair. The SolWest and *Home Power* crews were discussing the event over a few beers. I mentioned that we should do a pre-fair workshop and install a permanent PV utility-intertied system at the fairgrounds. The big cheese of SolWest, Jennifer Barker, lit up like a supernova—"Yeah, let's do it!"

And that began months of work, mostly on Jennifer's part. She began canvassing the manufacturers of the gear—would they donate equipment to such a project? Would the local Grant County Fairgrounds be willing to host such a system? Would the local electric utility intertie with such a system? Would the local electrical inspector approve of it all? Would enough paying students show up to meet the mounting incidental project bills? Would we get it all on line in time for the SolWest Fair? Jennifer worked her butt off.

The Workshop

The plan was for Joe Schwartz and me to breeze into town three days before the fair to teach the

All the concrete work was done prior to the workshop.

workshop. The students at this workshop would install a permanent, utility-intertied PV system at the fairgrounds. It worked just like that—well, almost.

Joe and I didn't know what to expect. Neither of us had ever taught this workshop before, even though we'd both done other workshops and utility-intertied PV systems. We finalized our class notes on the long, eight-hour drive to John Day. We felt we were ready.

My major concern was the technical skill level of the students. I needn't have worried. Most of the nineteen students were very familiar with off-grid PV, and some even with on-grid PV. We were blessed with an experienced and energetic group of students. They were a joy to work with.

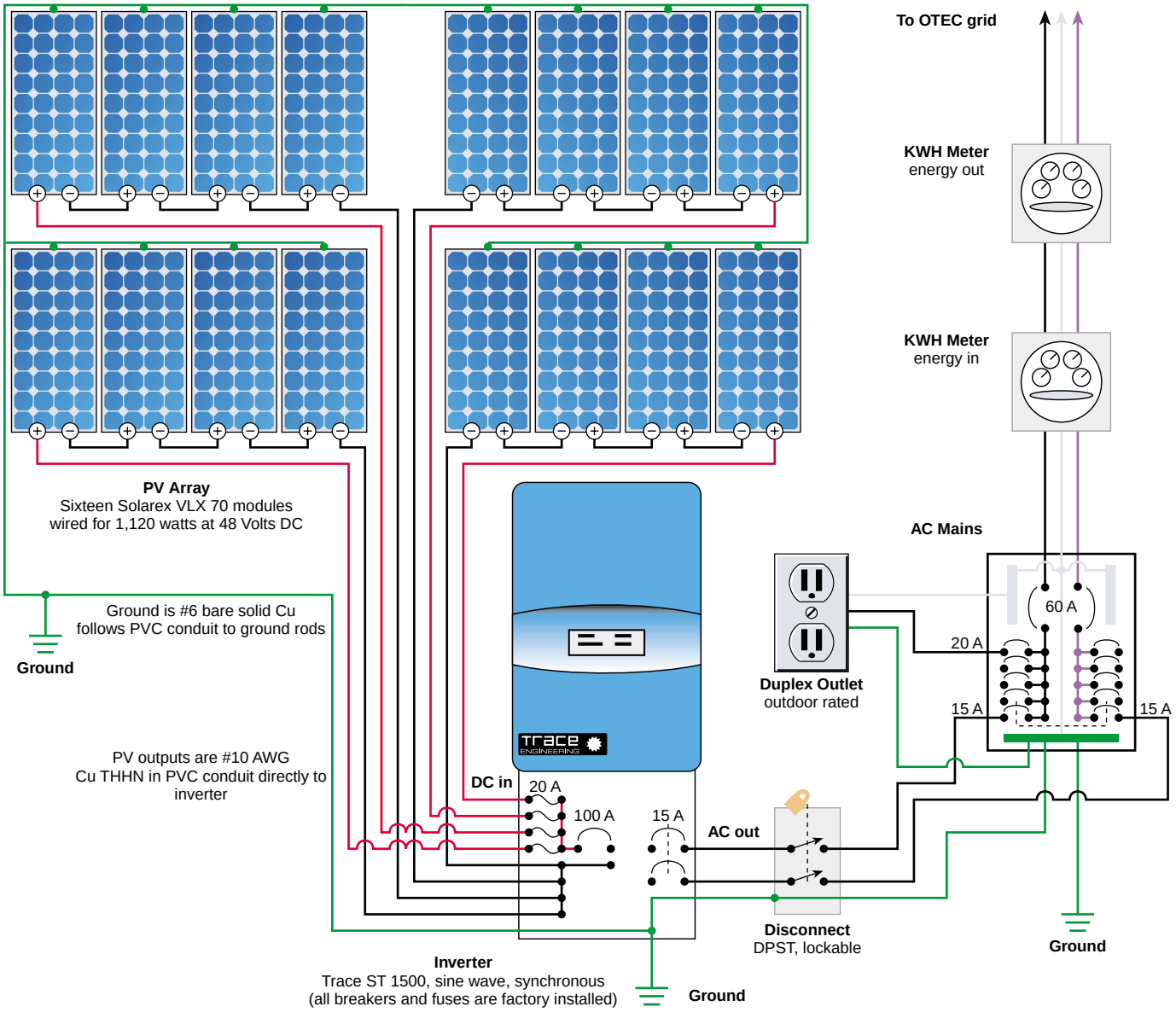
We started the class out with technical information and discussions about how PVs and inverters work. We discussed AC power quality issues, and measured the power quality of the local grid and various inverters using the Fluke 43 power quality analyzer. We discussed energy issues, *NEC*® issues, wire sizing, PV mounting structures, the legal issues of net metering PV systems, and a host of other PV issues.

Joe Schwartz discusses safety issues with the class.

We installed a temporary guerrilla solar system using a couple of the modules and a Trace Microsine inverter. We took some lessons out in the sun with the Solar Pathfinder, and even ran a current versus voltage (IV) curve on one of the modules we were installing. We had a fun-filled couple of days discussing a subject that interested all of us—solar electricity.

Top: A working guerrilla solar system.
Center: Running an IV curve on one of the PV modules.
Bottom: Learning to use the Solar Pathfinder.

SolWest Utility-Intertie PV System



System Design

Batteryless, grid-intertied PV systems are far easier to design than off-grid systems. Since there is no need to worry about the system running out of electricity (provided the utility doesn't fail), a detailed load analysis isn't required. The system components simply need to be sized to handle the PV array's maximum power output. It doesn't get much simpler in the world of solar electricity.

In batteryless utility-intertie systems, there are really only three major components—PV modules, a mounting structure for the PVs, and a utility-intertie inverter. There are no batteries to lug, battery interconnects to manufacture, or charge controllers to wire up and fine tune.

The size of a utility-intertied PV system is limited primarily by one factor—the budget. Since the major system components were to be donated in this case, the limit was the generosity of the RE industry. BP Solar kicked down with sixteen Solarex VLX-70 PV modules with a total rated wattage of 1,120 watts.

Two Seas Metalworks donated two of their hurricane-proof, pole-mount PV racks. Trace Engineering donated one of their brand new 1,500 watt Sun Tie inverters. Many thanks to these companies for giving so freely of

their products. This was going to be a bang-up system on permanent public display!

Jennifer saw to it that the mounting poles were properly installed in their concrete holes, and that all the 120 VAC wiring and utility meters were installed prior to the workshop. Special thanks to Dennis Voigt, a local electrical contractor, for donating his time for the pre-fair groundwork.

Jim Sanders, the local contractor who donated time to put in the PV mount poles, also built support boards of locally milled pine for both the AC wiring and the inverter. He built a mini-house for the inverter and wiring, with locking barn-style doors that could be opened for display.

The Installation—Day One

At noon on the second day of the class, we went out into the intense sun and began the actual installation. Joe and I had counted and checked all the parts the previous day. We paid special attention to the PV racks, and yes, every part was there.

What we didn't know was that due to a communication error, we had the wrong racks. We discovered this chilling fact only after the class laid the modules out on their shipping cartons and began laying out the racks. Everyone froze with "what's wrong with this picture?" looks on their faces. The donated Solarex VLX modules were far wider than what the racks were designed to hold.

Our hearts sank. Here we had a class that had come to install this system. In just 48 hours, the SolWest RE Fair would begin, and this system was going to be on display. If this were a regular home installation, we'd have just sent the racks back and returned to do the installation on another day.

But this wasn't a regular installation; it was a pre-fair workshop. These folks had traveled hundreds of miles and paid good money for the educational experience of actually installing a utility-intertied PV system. We had to do something, and we had to do it very quickly.

Joe and I gave the class an early lunch and began frantically searching for a solution. A quick call to Two Seas confirmed what I suspected. There was no way that they could ship us a rack in time to complete the class and have the system operational by fair time. They had the rack in stock, but there was no way to ship it quickly enough. We were on our own.

Workshop participant Chris Worcester, Joe, and I jumped into the van and began combing the tiny town of John Day for the material we needed. We visited every store we even remotely thought might have aluminum channel stock. We checked out both hardware stores, the welding shop, and even dug through the metal scrap pile at the local glass shop. Finally, we lucked out. The lumberyard had just enough 1 inch (25 mm) galvanized angle iron to extend the racks to accommodate the VLX modules.

Top: Hey, the rack is too small for these PVs....
Bottom: A successful rack klüge using steel angle iron.

Country Klüge
We bought ten 10 foot (3 m) pieces and rushed back to the fairgrounds where the students were just returning from lunch. We set about making strong extensions for the existing racks by bolting together the metal angle stock to form "C" sections. This required much additional drilling and cutting. The class was wonderfully understanding. Most were country "can-do" folks who were deeply acquainted with the art of klüge.

One person in particular was invaluable—Chris Worcester of Solar Wind Works in Truckee, California. Chris may have been a student in the class, but his design expertise and cool head were really what made this klüge work. Even though we had to modify the beautiful Two Seas racks, this klüge would be strong and permanent.

By the end of that afternoon, we had all the modules on the racks and the racks atop the poles. Lifting a rack with four pre-wired modules to the top of the poles was a big job. I was thankful that we had many hands. Before quitting time, we also had the Trace inverter installed in its wooden mini-house and ready for wiring the next day.

Each PV subarray is composed of four 70 watt modules wired in series, so we had four subarrays on two different racks. Each subarray had its own home run of #10 (5 mm^2) copper wire to the Sun Tie inverter. Each home run was about 40 feet (12 m) in length. All the wiring from the PV array to the inverter was encased in Carflex conduit on the racks and non-metallic conduit for the underground runs.

Trace Sun Tie Inverter
This inverter is a brand new Trace product designed specifically for putting solar electricity onto the grid. It is purely utility-interactive, and designed to work without a battery. It contains individual fuses for each subarray, and all the safety and protection gear required by the *NEC* and the IEEE for utility interconnection of solar electricity. It was a snap to install.

This new inverter has maximum power point tracking (MPPT) that extracts the maximum available power from the PVs, regardless of module temperature or solar insolation. The Sun Tie (ST) inverter also contains a nifty information display that shows grid AC voltage and frequency, array voltage, instantaneous power produced, and total daily power produced. Once the system was installed and working, we were constantly watching this display to see exactly how much solar energy we were putting on the grid.

The Installation—Day Two
After modifying the racks on the first day of the installation, the second day was smooth sailing. All we had to do was hook up the wiring at the Sun Tie and we were on line. We worked at a leisurely pace and finished at about 3 PM daylight savings time (that's 2 PM sun time). After the last connection was made, Joe flipped the circuit breaker connecting the system to the grid. The entire class rushed to the utility meter to watch it spin.

Top: Attaching the home runs to the array.
Bottom: Pulling the home runs through the conduit and into the inverter.

Measuring PV array voltages before putting the Sun Tie inverter online.

A separate service was installed for the fairgrounds' utility-intertied PV system. It consists of a main panel and two unidirectional meters—one for consumption from the grid and the other for solar electricity put on the grid. Why the local utility insisted on two meters was and still is a mystery to us.

Apart from a single duplex receptacle that is rarely (if ever) used, there is no consumption at this service's site. Because the PV system had its own unidirectional meter, it didn't spin backwards, it spun forwards. This led to a lively discussion among the workshop participants, and we decided that henceforth we would term all solar electricity placed on the grid as spinning the meter "forward." A small step forward, but it's definitely in the right direction.

After spending an hour cleaning up the job site, we looked at what we had accomplished. In about sixteen hours of actual installation time, we had put in a system that would deliver four to five KWH of solar electricity to the local electric power grid every day. I'll bet that everyone who helped with this installation will often think about how this system is performing.

Political Aspects

Perhaps the greatest lessons we learned from this system were not technical, but political—as in "of the people." This solar-electric system is all donated. The manufacturers donated over US$8,000 worth of solar-electric equipment—PV modules, mounting racks, and inverter.

The crew.

Jennifer and her local assistants donated US$2,000 for the groundwork of poles, holes, concrete, wire, and conduit—all of it installed and inspected before the fair. The students donated—no, actually paid for—their labor of learning and installing. Joe and I donated our time and expenses. We all—from industry biggies to on-point grunts—freely gave what we had to give. This was a labor of love and hope.

I wish I could include the Oregon Trail Electric Coop (OTEC) in the list of folks who were giving because they believe that solar electricity represents a better future for us all. But I can't.

OTEC is like many small rural electric coops. They seem to see locally-produced solar energy as a threat to the way they have always done business. It's a change in a structure that isn't used to change. OTEC insisted on two meters, and rightfully under the Oregon net metering law, installed them at their own expense. OTEC is pursuing an agreement that would net these two meters against one another. Since there is no regular load on the grid meter, there is no usage for the PV meter to net against. This qualifies all the energy that these PVs produce as "monthly excess."

Under Oregon's net metering law, monthly excess energy is either granted to the utility or sold to them at avoided generating cost. This system, the result of so many people's generosity and hard work, isn't really a net metering system at all. It's a donation of solar electricity to OTEC's grid.

To add insult to injury, OTEC is now trying to insist on a US$15 per month meter reading fee (the PV system makes about US$7 worth of electricity per month). They even went so far as to suggest a US$15 fee for *each* meter when they formalize their net metering policy.

But wait, there's more…. Off the charts is their latest proposal of a US$35 annual inspection fee so that they may determine that this peanut-whistle PV system is not a danger to their grid.

A Legacy for the Future

Technology and politics aside, the real accomplishment of this system is a daily average (so far) of 4.33 KWH placed on the grid. This will go on day after day for years. This system will just keep on pumping out the electricity as long as the sun shines.

Over the next twenty years, this small system will displace 20 metric tons of CO_2 that would have been produced to make the same quantity of electricity. All the folks who worked on this system have left this amazing new source of electricity as a legacy to the future. I salute them!

Hoops & Hurdles

Jennifer Barker

Getting permission from the utility to install the system at the fairgrounds was easy. The new net metering law, Oregon HB3219, says that the utility has to allow grid-intertied PV, and they were going to obey the law. No mention was made of extra costs or charges, because the law had just been passed, and Oregon Trail Electric Cooperative (OTEC) had no idea what their policy would ultimately be.

Dealing with OTEC's engineering department was easy too. Busy as he was, Chief Engineer Mike Chase was frequently in John Day for meetings, and was always willing to return my phone calls and get together to discuss configuration. His main concern was how they would meter a system that would produce more power in a month than was being consumed. He recommended two meters for our system.

Grant County's planning department was very cooperative. They looked at the wiring schematic and declared the solar installation to be a "branch circuit" because it did not have a subpanel. So the additional cost on the permit already issued for the main panel and utility hookup would be US$3.

Trouble Comin'

The first indication of a potential problem was when I received a desperate email from Tom Wykes, Oregon State Extension energy agent in Bend. Comment was needed quickly. Central Electric Coop was formulating their net metering policy and proposing prohibitive fees. My contact at OTEC informed me that they would soon be following suit, and I asked for a copy of their proposal as soon as it became available.

OTEC was proposing administrative and inspection fees of US$131 annually for net metering customers over and above the base fees and power in/out. This would make net metering a loss to almost all customers with the 25 KW-or-under systems allowed by the law. When the co-ops negotiated for the terms of the law, they promised to "make it work." But this was not working. In fact, it was worse than no law at all!

OTEC's concern was that distributing the cost of administration (hand billing in case of negative meter readings) among all their members would amount to a "subsidy" of the net metering customers, and raise the bills of all their customers.

SolWest organizers: Ken Primrose, Nancy BeBout, and Jennifer Barker.

Speak Up!

The law said they had to take public comment. The hardest part was lining up people who cared enough to drive the miles to the OTEC office in Baker City and comment in person. We had exactly two and a half weeks notice, and only two weeks for written comment to be submitted. Six dedicated RE supporters attended the meeting, and one other whipped out a letter of comment in time.

OTEC was represented by their general manager, member services manager, head of accounting, and chief engineer. The purpose of the meeting was for these people to collect our comments, digest them into suggestions, and later present them to the board of directors.

The comments made by EORenew members were very sharp. They represented all levels of personal experience, from Kay Firor and Kent Osterberg who had operated a permitted grid-intertied system on their house for many years (with no extra fees!) to Chuck Koch, proposing to install a 15 KW Jacobs wind genny as soon as possible, to Linda Harrington, who dreams about adding a solar-electric system to her bed and breakfast in Prairie City.

Since I am not an OTEC customer, I was regarded with some impatience as an "activist." But the OTEC members and a local installer were listened to very courteously. Some of us had our comments in written form, and these were accepted at the meeting. I don't know what the board's decision will be in the end, but from the rumors, we had more turnout for comment than any other utility.

Do Your Homework

People whose utilities are proposing prohibitive policies towards RE on-grid need to buckle down and do some serious research. The folks who came to the meeting had done the homework. We had contacted our friends in the business, learned the technical aspects of the safety issues, and found out how other utilities are dealing with net metering and how they regard RE on-grid as a benefit.

Without being confrontational about it, we made OTEC realize that they were acting like they were afraid of the dark. If you want to get your utility to back off, offer help and support for the learning process that these utilities must go through. We have the contacts and the information they need, and we should offer it freely.

Wanted: RE-Friendly Policy

For now, the fairgrounds' system is being net-metered as they all should be—retail in, retail out, and no extra fees. OTEC emphasizes this policy is only for us, and only until a formal policy is instituted. Perhaps even if they charge fees for regular customers, we can get them to leave the fairgrounds as it is now, because it is a public demonstration on a not-for-profit property.

But that is not enough. We want the whole thing—not a handout, but a fair and forward-looking policy that encourages all their members to put distributed, RE-based generation on the grid!

Access

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