CLEARING THE CLOUDS

PV GRID-TIE—BATTERY OR NO BATTERY?

When people first think about a PV grid-tie system, they may expect part of its function to be backup during power outages. However, that necessitates batteries, a relatively complex installation, user attention, and eventual battery replacement. Is this what your customer really wants?

Most potential grid-tie customers are affluent consumers who pay no attention to their electrical usage. A backup system to supply the entire home with power for even one day is usually too large to be a viable sale. The battery bank can be sized to run only some priority circuits, but that necessitates wiring the priorities into a sub-panel and avoiding heavy loads like electric heaters. This can require the tracing of circuits and long discussions with the customer, just to write an estimate! If dual-voltage and shared neutral issues come up, it's more complicated. A battery bank also requires energy to maintain. A battery system will pump 10-40% less energy into the grid than the same array in a non-battery system. It will also raise more issues with the power company and the electrical inspector.

A non-battery grid-tie system is the essence of simplicity. It's more efficient and economical, and far less burden on everybody concerned. If your customer's electrical service is reliable, with only a few hours' blackout per year, you can make the case for a non-battery system. ON THE OTHER HAND, if they live in an area with frequent blackouts, they may be ready for a battery system. Ask yourself these questions:

- What is the customer's priority—maximum economic and environmental value, or emergency backup?
- What type of person is your customer—hands-on participant, or hands-off consumer?
- What are YOUR priorities—simplicity and volume of sales, or highly customized service?

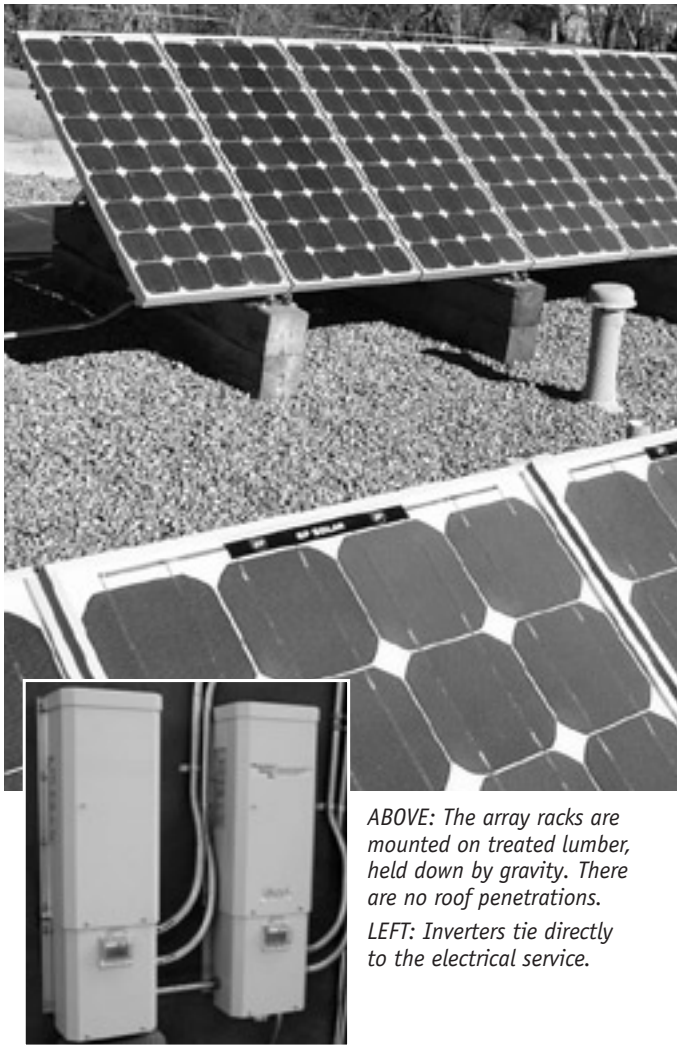
If your customer wants more than a few hours perday of backup, you can assume they will need a generator. Usually the power goes out when there is a storm, and that means little solar input to help the autonomy. So why not go with the generator direct for backup, and have the solar be non-battery? It will cost much less and give better performance for those areas with longer outages.

If your customer needs backup for only a modest critical load, you can always recommend a separate UPS (uninterruptible power system). For backup water supply, why not suggest a storage tank?

Following are two case studies, a non-battery system, and a battery system, as installed by Dankoff dealers.

CASE STUDY—SIMPLE PV GRID-TIED SYSTEM ON A SANTA FE HOME

Some people believe that getting a portion of their power from renewables is the right thing to do, and they will invest in that conviction whether or not it pays for itself. Positive Energy in Santa Fe found such a customer. He didn't even ask about payback. The system consists of 32 BP-270 70-watt modules, low-profile racks by Two Seas, and two Advanced Energy GC-1000 inverters.



ABOVE: The array racks are mounted on treated lumber, held down by gravity. There are no roof penetrations.

LEFT: Inverters tie directly to the electrical service.

The local power company was cooperative. They require a visible-break lockable disconnect to be available to utility personnel. They allowed the existing meter to fulfill that requirement, so no additional disconnect was installed. After the installation, they did a simple shut-down test by disconnecting the service and verifying zero inverter output. They also required a one-line block diagram of the system to be posted near the meter.

Allan Sindelar of Positive Energy says "There's amazingly little to the system. We had no problems whatsoever." The Santa Fe City Electrical Inspector's comment: "I look forward to more of these."

The utility's residential intertie program offers full retail credit for the kWh fed to the grid, using a normal (non-ratcheting) meter. Any credit balance of kWh at end of month carries over to the next month, and is reset to zero once per year. This is intended to make it simple and easy, but to discourage systems large enough to offset annual consumption.

CASE STUDY—PV GRID-TIE AND BACKUP SYSTEM AT A SOUTHERN CALIFORNIA HOME

by Jill Beebe, Solar Cell Sales (San Miguel, CA)

This is the story of an installation by Solar Cell Sales. We obtained components and tremendous technical support from Dankoff Solar Products. The system takes advantage of the California Energy Commission rebate program and the 15% State Tax Credit.

New BP Solar 160 watt modules with MC connectors made this a low-labor installation.

Our customer, a couple in Monterey County, is about to complete their project and bring their 9600 watt solar energy system on line. Once they had made their decision to go with solar power, we presented them with several grid interactive designs. They made a choice that fit their energy requirements and budget, utilizing a battery bank for backup. We worked with a local electrical contractor to help us plan and install the system.

The home is in a rural area. It has its own well, and several large electrical loads, so the customer decided on the Trace Power Module with dual SW5548 Inverters with 11kVA capacity at 120 and 240 VAC. Since this is a grid interactive/battery backup system, we installed a critical load subpanel separate from the main service, to supply the customer's chosen loads in case of a power outage.

The array is installed on a south-facing hillside. Pumped concrete piers were installed on the steep hillside, to mount the adjustable racks by Unirac, and to provide a walkway and steps where needed for easy access. We used large, 160 watt modules (BP Solar SM3160S) to reduce labor. They received an excellent rating from the California Energy Commission based on PVUSA test conditions. The array is clean and good looking.

The local building inspector made frequent visits and has passed all the work completed. Once the system is up and running, the power company will make its inspection. The customer's Net Metering Agreement and California Energy Commission Rebate Reservation have already been completed. Once they have the final sign off sheet from the local building department, they can look forward to generating their own clean energy.

We enjoyed working with the professional team at Dankoff Solar Products. They delivered the goods and answered all our questions.

COST COMPARISON OF NON-BATTERY vs. BATTERY SYSTEMS

Jay Peltz of Peltz Power (Redway, CA) provided us with this cost comparison. Both are based on a 2.8 KW PV array.

NON-BATTERY SYSTEM
Array: 2.8 KW on roof rack
Inverter: Sunny Boy or Trace ST
System disconnect as per local utility
DC system disconnect
Labor: 2 workers X 2 days max.
Estimated sale price: $23,000

BATTERY SYSTEM
Array: 2.8 KW on roof rack
Trace SW 4048 inverter
Safety components: PV disconnect, DC system disconnect, breakers, GFI, 2 inverter bypass switches for the grid side

and for the genset side (Trace Power Module system)
PV charge controllers with MPPT
Battery bank (modest size): 8 x 100 amp-hr, 12v sealed batteries
Battery and inverter
Battery enclosure
Subpanel parts
KWH meter
Labor: 2 workers X 3-4 days
Estimated sale price: $30,000

The price of the battery system can vary greatly. A main variable is the type of main AC load center. If it is surface mount, the addition of a subpanel is easy. If it is flush mount, especially in plaster, it can be a half-day job. If there is a water well pump to run, a 115/230V transformer is usually necessary (another $400). In addition, there will be a higher maintenance cost plus battery replacement after about 10 years.

EFFICIENCY COMPARISON: NON-BATTERY vs. BATTERY SYSTEMS

Now let's compare the two systems above, in terms of energy output (watt-hours/day). There is loss in every step of energy conversion, including storage and release. Batteries take their toll in two ways. They have a typical energy efficiency of 80%, so 20% of any cycled energy is lost. Float-charging batteries (to maintain them at full charge) also consumes energy, to compensate for self-discharge and to keep them optimally maintained. A battery system will yield about 10 to 40% less energy. The amount of loss depends on the size of the battery bank and how much it cycles, the quality of the PV charge controller, and the quality of the energy management software in the inverter.

The Trace SW inverters use grid power to maintain the battery bank with a float charge, even through the night. If the solar day ends with the battery at less than 100% state of charge, it will draw grid power to recharge it during the night. Advanced Energy Multimode inverters use a smarter management system. It will wait for solar power to recharge the battery, and not draw grid power unless the battery drops to a low state of charge. Float charging is timed to a minimum, to further maximize efficiency.

Another source of loss in a battery system is through the drop between a PV array's maximum power point voltage and the voltage of the battery bank. This mismatch can be nearly eliminated through the use of a charge controller with MPPT (max. power point tracking). Without MPPT, the average loss ranges from around 5-15%, with the greater loss occuring in cool climates. During cold weather, when the array voltage is highest, loss can reach 25% without MPPT, if the batteries are low in charge. To maximize the charging of any PV-battery system, use an MPPT-type charge controller like the Solar Boost from RV Power Products. For details, see Dankoff SunPaper 6 (Spring 2000) or www.dankoffsolar.com, Reference section. Advanced Energy inverters have an MPPT charge controller built-in. All grid-tie, non-battery inverters include MPPT in their conversion scheme.

To minimize the losses in a battery system, consider the Advanced Energy Multimode inverter with a relatively small battery bank. For systems using the Trace SW, use a Solar Boost charge controller and hope that a future software upgrade will provide better energy management.

You should be clear with your grid-tie customers to help them make informed choices about their system, and to know what to expect. If they want a substantial battery backup capacity, they must understand that they will need a larger PV array to offset a given portion of their utility bill.

PV GRID-TIE—SOME RULES OF THUMB

Power Output

Peak watts AC output of a non-battery grid-tied system will be approximately 70% of the RATED power of the PV array. Losses are caused by the following: temperatures that are normally higher than the cool 24°C standard cell temperature at which the modules are rated; dust and dirt on the array; imperfections in the solar orientation; inverter and wiring losses.

Energy Output

Annual energy output of a grid-tied, non-battery system in the central and arid western parts of the USA is around 4 KWH per rated KW of PV array. It would be fair to assume a battery system's output to be about 3 KWH. Your installations may do better, but it's best to estimate on the safe side.