OFF-GRID INVERTER buyer's guide

by Kelly Larson

Living or working off-grid means you are responsible for all your own energy needs—you produce, store, and process every kilowatt-hour you consume. One part of that processing is converting the DC energy in your batteries to AC energy for use in standard AC appliances. This conversion is accomplished with an inverter.

There are several off-grid (a.k.a. "stand-alone" or "remote") inverters to choose from. Modern inverters are reliable, quiet, and come in a variety of sizes. This article will help demystify the inverter selection process so you can choose an inverter that is appropriate for your needs. We have restricted our list to residential-sized inverters (those that produce 1 to 6 kW), but the same process applies to larger systems. Only inverters that meet Underwriters Laboratories (UL) 1741 standards, as tested by a recognized certifying agency, are included in the list.

THE SPECS

All of the specifications listed in the table were provided by the manufacturers. Note that some published specifications are not third-party verified, i.e., by UL or an equivalent testing agency, and there have been instances in the past when some manufacturers published incorrect values—like the no-load draw, for example.

One "spec" that is not shown in the table is a comparison of how long each inverter has been in the field. This can be important since it is possible that newer models have not had sufficient testing prior to release. Also, new equipment may have software bugs or integration issues that might not yet have been discovered—which may make you an unintentional beta-tester. So if you are on the fence between two choices of inverters, you might consider how long the inverters and companies have been around before you make your decision.

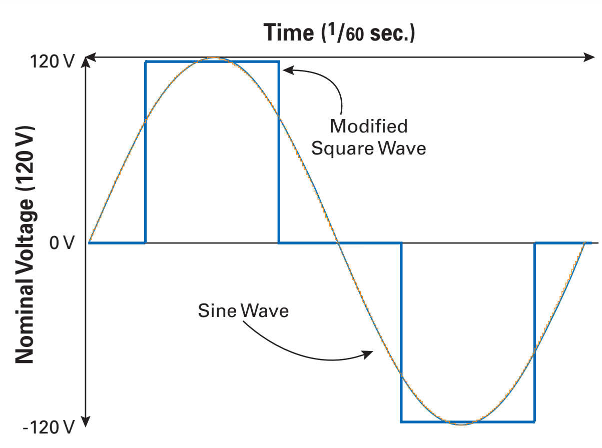
Waveform (sine wave vs. modified square wave). Modern off-grid inverters are sold with two waveform options: sine wave and modified square wave (sometimes called "modified sine wave"). Sine wave output, which has low total harmonic distortion, will power virtually any type of load, even sensitive audio electronics. Although almost all residential inverters have sine wave output, a couple of modified square wave inverters made our list for budget systems. For instance, a typical 2,800-watt sine wave inverter costs about $2,100, while a modified square wave inverter with the same output retails for about $1,500. However, modified square wave inverters may not run some types of loads satisfactorily, and some loads won't run at all (see "Problem Loads" sidebar).

Problem Loads with Modified Square Wave Inverters

Take heed if you're considering buying a modified square wave inverter to shave a few bucks off your system costs. A whole raft of modern appliances won't run as well and some not at all on this waveform:

- Laser printers, photocopiers, and anything with an electrical component called a thyristor
- Anything with a silicon-controlled rectifier (SCR), like those used in some washing machine controls
- A few laptop computers
- Some fluorescent lights with electronic ballasts
- Some battery chargers for cordless tools
- Some new furnaces and pellet heaters with microprocessor controls
- Digital clocks with radios
- Appliances having speed/microprocessor controls (like some sewing machines)
- X-10 home automation systems
- Medical equipment such as oxygen concentrators

In general, because the total harmonic distortion is higher in modified square wave inverters, motors will run hotter (less efficiently), and likely not last as long. Additionally, a modified square wave inverter will often cause a "buzz" to be heard from audio devices and sometimes other appliances like ceiling fans and microwave ovens.



OutBack FX series inverters also come in integrated packages.

Courtesy www.outbackpower.com

Total harmonic distortion (THD) is the measure of how closely the waveform matches a perfect sine wave. Glitches, transients, harmonics, spikes, and distortion all describe alterations to the waveform shape. Inverter electronics produce steps to approximate a true sine wave—the greater the number of steps, the less THD an inverter will have.

A THD of 0% is a perfect sine wave, and the larger the percentage, the farther it deviates from a sinusoidal waveform. Sine wave inverters typically show a THD of 5% or less, while the THD of modified square wave inverters may range from 10% to 40%. Because THD for modified square wave inverters varies and depends on the type of loads running, values given from manufacturers are hard to compare fairly, so these numbers are not listed for modified square wave inverters.

It is important to note that grid electricity also can have waveform distortions due to activity from all the different loads on the grid (such as large motors starting), which can cause transients in the utility waveform. Because of this continual variation of grid activity, sine wave inverters often have even less THD than grid electricity.

Rated Continuous Output Power. An off-grid inverter must supply enough power to meet the needs of all the appliances running simultaneously. Before selecting an inverter, you must know the loads you will power—and their power and surge needs. (Surge specifications are discussed separately.)

Sizing an inverter for an off-grid system, which is based on instantaneous load, is very different from sizing a grid-direct inverter, which is determined by the RE power source (i.e., PV array watts). A grid-direct inverter's job is simply to convert all the DC from the PV array into AC power, which is fed back into the house electrical system—then onto the grid if production exceeds household energy consumption. In a grid-direct system, the inverter is not responsible for meeting the AC loads, since practically unlimited utility power is available. For example, a 2,000 W grid-direct PV system would require choosing an inverter that *accepts* 2,000 W of PV on its DC input.

In the case of an off-grid system, the inverter is usually responsible for providing energy to *all* the AC loads. Say you need to simultaneously power 2,000 W of AC loads. For an off-grid system, you'd need an inverter that could *supply* at least that amount. Note that the PV array size does not enter into this inverter sizing. (For more details, see "Off-Grid Inverter Sizing" sidebar on page 99.)

Nominal Battery Voltage(s). Each inverter has a nominal battery voltage that it can be connected to. Common off-grid inverter battery voltage options are 12, 24, or 48 volts.

Smaller systems are typically matched with lower power inverters and lower battery voltages. The converse is true for bigger systems. For example, several 2,000 W inverters have a 12 V nominal battery bank voltage; 4,000 W models generally have 24 or 48 V battery bank voltages; and 5,000 W units are typically matched to 48 V battery banks only.

For the same power, higher nominal battery bank voltage means lower amps (watts ÷ volts = amps) in the battery cables—which translates to less energy loss for the same-sized cables, or smaller-diameter, less expensive cables and smaller overcurrent protection for those cables.

Some inverter companies offer models in unusual voltages. Exeltech's line of inverters, for example, includes models that can connect to 32, 66, or even 108 V battery banks. These inverters are used in various industries, such as the telecommunications industry.

Output Voltage. We've only listed inverters used in the United States to power 60 Hz 120 or 120/240 V loads. For other countries, inverter models with other output specifications do exist, often in the same model lines as listed. Most off-grid inverters have 120 V output, although some have 120/240 V ouput, which allows the inverter to power both 120 V and 240 V loads. Inverters with 120/240 V output cannot supply all their output on one leg. They are usually derated by 75% or so

Courtesy www.magnumenergy.com

The Magnum MS Series inverter is one of several models with a remote display option.

Courtesy www.xantrex.com

A Xantrex XW series inverter. At 6 kW, it's the largest inverter in the lineup.

for single leg (120 V) output only. To maximize performance, be sure to balance the loads on both legs when running 120 V loads. Inverters with 120/240 V input also can accept both legs of a 240 VAC generator, enabling you to get maximum capacity for battery charging with a single inverter.

Peak Surge. Some loads (like motors) require significantly more power during startup than they need to run. To start these loads, inverters will briefly "surge" or run at higher than their continuous power rating. Surge ratings include the maximum amperage and a time period that the inverter can run at that high power level without sustaining damage or turning off to protect itself.

Inverters may have several surge ratings (stated in either AC amps or watts), each corresponding to a specified time period. Most load surge happens in the first few milliseconds of startup. For inverters with several surge ratings, generally it is fine to consider the shortest one. For instance, OutBack Power Systems' VFX3648 can surge to 70 amps for 1 ms. Typically this is the rating you would use to determine if the inverter can supply enough power for your surges. If in doubt, talk to the inverter manufacturer to make sure the unit can supply the surge capability you need.

Loads with induction motors, like washing machines, pumps, and power tools, can have large startup surges—up to seven times the running wattage. Look for "VA" on the nameplate, "locked-rotor amps," or "surge rating" for clues that the load may have a high surge. To determine the surge of a particular appliance, either measure the load's maximum amps with a recording clamp-on ammeter, look for "start amps" in the specification sheet, or call the appliance manufacturer.

Stackability. Some off-grid inverters include the capability to connect several units together to operate as a single, larger unit. Various stacking options allow 120 V inverters to work together to power 240 V loads (such as well pumps). These inverter configurations can accept both 120 V legs of a 240 VAC generator, allowing for full usage and balancing of the AC generator output, just like a single inverter with a 120/240 V output is capable of.

Stacking setups can allow one inverter to "sleep" while power needs are low, which helps reduce standby energy loss. Series stacking 120 V inverters means that the inverters have a 120/240 V output from two inverters. Parallel stacking two inverters means the inverters will output 120 V at double the amps of a single inverter. Some inverters can be stacked to supply three-phase power, often used for heavier machinery.

Some inverters have a 120/240 V output available from a single inverter (discussed previously), so series stacking is not necessary. They can be stacked in parallel to offer more capacity (higher amps).

Inverter Peak Efficiency. Efficiency is measured as the ratio of the inverter's AC power output to the DC power input from the batteries. Higher efficiency means that the inverter wastes less power while converting DC into AC.

Note that "peak" efficiency doesn't necessarily represent actual *operating* efficiency, which changes with the size of the AC loading on the inverter. Peak efficiency is typically reached at about two-thirds of the inverter's continuous output rating, and decreases as the continuous output rating is approached. Most inverter manufacturers publish efficiency curves in their documentation. It is wise to choose inverters that have high efficiency ratings across a wide range of output wattages.

(continued on page 102)

Off-Grid Inverter Sizing

Sizing an inverter is an important part of off-grid system design. Choose an inverter that's too small and you won't be able to run all of your loads, or it might not handle startup surges. One that's too large will be a waste of some of your purchase money and an inverter that operates under its maximum efficiency—which translates to needing more energy input.

Inverter sizing starts with adding up the power needs of the loads in your off-grid system, as shown for an example home in the table. When sizing the battery and array, also be sure to account for inverter efficiency loss in the calculation. A 10% loss is standard for off-grid inverters, since they often operate at less than maximum efficiency.

Example Inverter Power Loads

Load	Operating Power (W)	Surge Power (W)
5 CF lights, 15 W lights	75	*
Refrigerator	100	300
Laptop computer	45	*
Microwave	1,400	3,000
TV	140	200
DVD player	35	*
Vacuum cleaner	1,000	2,000
Totals	**2,795**	**5,500**

*Negligible surge

Surge loads are also noted, so that an inverter with enough surge capacity to start them can be selected. For our scenario, an inverter that can handle at least 2,795 W is needed. Ensure that the chosen inverter will surge sufficiently for the loads. It is best to use actual surge values for each appliance, by either measuring or obtaining specifications from the appliance manufacturer. Then add the total run watts to the maximum surge that might occur at any given time. In this example, if all the surging appliances happen to start at the same time the other appliances are on, the surge capacity will need to be 155 + 5,500 = 5,655 W. Another way to roughly guesstimate surge requirements would be to take your maximum simultaneous watts and multiply by three—in this case, that would be about 8,400 W (70 A).

If your budget is small, you can plan for load management so you can specify a smaller inverter. It is usually easy to remember that the inverter will not handle, for example, running both the microwave and the vacuum at the same time, which would reduce the inverter size needed to 1,795 W. However, although restricting the larger loads can be effective, this strategy gets more difficult to implement with each additional person in the household.

Also consider future expansion: Power needs grow in almost all systems, and upsizing to a somewhat larger inverter usually makes sense. Choosing an inverter that can be "stacked" with additional inverters to increase continuous output power will enable easier future expansion. Finally, off-grid inverters typically run most efficiently running at about two-thirds of their rated power. Rather than maxing out its load capacity, choosing a slightly larger inverter could allow it to operate in a more efficient power range. In the long term, this could offer better value—the loads will take less energy out of your system and the inverter will run cooler, subsequently lasting longer.

Possibilities

For our example home's loads, there are many possibilities that will work, including:

- Using load management: When simultaneous loads total less than 2,000 W, a 2,000 W inverter, like Exeltech's XP2000, is a relatively inexpensive choice. These inverters are easy to install and have a very accurate sine wave output. However, this choice offers no ability for expansion, greatly restricting system flexibility.
- OutBack's VFX3524 (a 3,500 W inverter) may be a good choice, since it has a higher power rating and a surge capability of 70 A.
- If 12 VDC loads are also part of the system, choose an inverter that will work with a 12-volt battery, like Magnum's MS2812, 2,800 W inverter. Most modern homes do not have DC loads. But if wire runs are short, continuous DC loads, such as an answering machine or fan, can run directly off the battery bank. Running continuous loads on DC allows the inverter to spend more time in its power-saving mode. The Magnum MS2812 has a 30 W no-load draw, but only draws 7 W in sleep/search mode.

Other Considerations

Waveform—Only budget systems have modified square wave inverters. Are there any loads on your list that won't run on a modified square wave? If so, rule out modified square wave inverters. For instance, in our example, the loads with motors, like the refrigerator, microwave, and vacuum, will run hotter and may not last as long running on a modified square wave inverter. Also, as side effects of the modified square waveform, interference may show up as lines on some TV displays or be heard in audio outputs. Some households choose to use a modified square wave inverter/charger, and separately supply more finicky audio-visual loads with a small pure sine wave inverter.

AC Output Voltage—If there is a generator with 240 VAC output or there are 240 VAC loads, consider inverters that have 120/240 V output to balance the generator output when charging batteries. These inverters can also provide 240 VAC to the loads *without* having to run the generator. Options here include the Apollo Solar TSW3224 or Xantrex XW4024. Alternatively, you can stack some 120 V inverters for 240 VAC output, or use a single inverter in conjunction with a 120/240 VAC step up/down transformer.

If a generator is used in the system, an AC battery charger will be needed to charge the batteries when RE is not available or the batteries need an equalizing charge. Most off-grid inverters have integrated AC battery chargers. A battery charger that's too small (compared to the generator's maximum output) will waste fuel and take a long time to charge the batteries. A charge rate that's too high will charge the batteries too fast and heat them up, causing harm to the battery bank, so be sure the settings on the AC battery charger are adjusted to the battery manufacturer's specifications.

Off-Grid Inverter Selection Guide

Manufacturer	Model	Wave-form	Max. THD (%)	Rated Continuous Output Power (W)	Nominal Battery Voltages	Output Voltage	Peak Surge (AC Amps)	Stackability	Inverter Peak Efficiency (%)
Apollo Solar www.apollosolar.com	TSW3224	Sine	5	3,200	24	120/240	80 A for 1 ms @ 120 V	Parallel	93
	TSW3648	Sine	5	3,600	48	120/240	80 A @ 1 ms, 120 V	Parallel	95
Exeltech www.exeltech.com	XP K (1100)	Sine	2	1,100	12, 24, 48	120	18.8 A for 3 s	No	89
	XP X (2000)	Sine	2	2,000	12, 24, 48	120	37.6 A for 3 s	No	89
	MX	Sine	2	1,000	12, 24, 48	120	17.1 A for 3 s	Series, parallel, 3-phase	89
Magnum Energy www.magnumenergy.com	MS4024AE	Sine	5	4,000	24	120/240	120 A for 1 ms @ 120 V	Parallel	93
	MS4448AE	Sine	5	4,400	48	120/240	120 A for 1 ms @ 120 V	Parallel	94
	MS2012	Sine	5	2,000	12	120	50 A for 1 ms	No	93
	MS2812	Sine	5	2,800	12	120	70 A for 1 ms	No	94
	MS4024	Sine	5	4,000	24	120	120 A for 1 ms	Series	91
	RD2212	Mod.	—	2,200	12	120	60 A for 1 ms	No	95
	RD1824	Mod.	—	1,800	24	120	70 A for 1 ms	No	95
	RD2824	Mod.	—	2,800	24	120	100 A for 1 ms	No	94
	RD3924	Mod.	—	3,900	24	120	150 A for 1 ms	No	93
OutBack Power Systems www.outbackpower.com	FX2012T	Sine	5	2,000	12	120	56 A for 1 ms	Series, parallel, 3-phase	90
	FX2524T	Sine	5	2,500	24	120	70 A for 1 ms	Series, parallel, 3-phase	92
	FX3048T	Sine	5	3,000	48	120	70 A for 1 ms	Series, parallel, 3-phase	93
	VFX2812	Sine	5	2,800	12	120	56 A for 1 ms	Series, parallel, 3-phase	90
	VFX3524	Sine	5	3,500	24	120	70 A for 1 ms	Series, parallel, 3-phase	92
	VFX3648	Sine	5	3,600	48	120	70 A for 1 ms	Series, parallel, 3-phase	93
SMA America www.sma-america.com	SI 4248U	Sine	3	4,200	48	120	140 A for 5 s	Series, parallel, 3-phase	95
	SI 5048U	Sine	3	5,000	48	120	150 A for 100 ms	Series, parallel, 3-phase	95
Xantrex Technology www.xantrex.com	XW4024	Sine	5	4,000	24	120/240	75 A for 20 s @ 120 V	Parallel	95
	XW4548	Sine	5	4,500	48	120/240	70 A for 20 s @ 120 V	Parallel	95
	XW6048	Sine	5	6,000	48	120/240	105 A for 7 s @ 120 V	Parallel	95
	TR1512	Mod.	—	1,500	12	120	50 A for 10 s	Series	90
	TR2412	Mod.	—	2,400	12	120	80 A for 10 s	Series	92
	TR1524	Mod.	—	1,500	24	120	50 A for 10 s	Series	92
	TR2424	Mod.	—	2,400	24	120	80 A for 10 s	Series	93
	TR3624	Mod.	—	3,600	24	120	120 A for 10 s	Series	94

*If out of warranty: $100 flat-rate fee applies for any repairable failure

No-Load Draw (W)	Search Power (W)	Battery Charger Max. Current (DC Amps)	Battery Temp. Sensor	Generator Start	Metering	Remote Display	Integrated System Available?	Dimensions (In.)	Weight (Lbs.)	Warranty (Yrs.)
27	5.0	100	Yes	Optional	Yes	Optional	Yes	22.5 x 9 x 7.25	49.0	5
27	5.0	70	Yes	Optional	Yes	Optional	Yes	22.5 x 9 x 7.25	49.0	5
10 (Optional)	—	No	No	No	No	No	No	3.6 x 7.7 x 15.1	10.0	1*
12	—	No	No	No	No	No	No	4 x 9 x 18	15.0	1*
20	—	No	No	No	Optional	Optional	No	Various x 7 x 15	7.5	1*
27	<6.0	105	Included	Optional	Optional	Optional	No	13.75 x 12.65 x 8	54.5	2
25	<8.0	60	Included	Optional	Optional	Optional	No	13.75 x 12.65 x 8	54.5	2
25	7.0	100	Included	Optional	Optional	Optional	No	13.75 x 12.65 x 8	42.0	3
30	7.0	125	Included	Optional	Optional	Optional	No	13.75 x 12.65 x 8	55.0	3
25	7.0	105	Included	Optional	Optional	Optional	No	13.75 x 12.65 x 8	55.0	3
20	2.4	110	Included	Optional	Optional	Optional	No	13.75 x 12.65 x 8	38.0	2
12	7.2	50	Included	Optional	Optional	Optional	No	13.75 x 12.65 x 8	38.0	2
19	7.2	80	Included	Optional	Optional	Optional	No	13.75 x 12.65 x 8	42.0	2
25	7.2	105	Included	Optional	Optional	Optional	No	13.75 x 12.65 x 8	45.0	2
20	6.0	80	Optional	Yes	Yes	Optional	Yes	16.25 x 8.25 x 13	62.6	2
20	6.0	55	Optional	Yes	Yes	Optional	Yes	16.25 x 8.25 x 13	62.6	2
23	6.0	35	Optional	Yes	Yes	Optional	Yes	16.25 x 8.25 x 13	62.6	2
20	6.0	125	Optional	Yes	Yes	Optional	Yes	16.25 x 8.25 x 12	61.0	2
20	6.0	85	Optional	Yes	Yes	Optional	Yes	16.25 x 8.25 x 12	61.0	2
23	6.0	45	Optional	Yes	Yes	Optional	Yes	16.25 x 8.25 x 12	61.0	2
22	<4.0	100	Included	Yes	Yes	Optional	Yes	15.35 x 23.23 x 9.65	86.0	5
25	<4.0	100	Included	Yes	Yes	Optional	Yes	18.4 x 24.1 x 9.3	139.0	5
24	<8.0	150	Included	Optional	Yes	Optional	Yes	23 x 16 x 9	115.0	5
26	<8.0	85	Included	Optional	Yes	Optional	Yes	23 x 16 x 9	115.0	5
28	<8.0	100	Included	Optional	Yes	Optional	Yes	23 x 16 x 9	125.0	5
26	4.2	70	Included	Optional	Yes	Optional	Yes	8.5 x 7.25 x 21	40.0	2
25	4.2	100	Included	Optional	Yes	Optional	Yes	8.5 x 7.25 x 21	42.0	2
25	4.1	35	Included	Optional	Yes	Optional	Yes	8.5 x 7.25 x 21	40.0	2
24	4.1	70	Included	Optional	Yes	Optional	Yes	8.5 x 7.25 x 21	45.0	2
24	4.8	70	Included	Optional	Yes	Optional	Yes	8.5 x 7.25 x 21	45.0	2

SMA America's Sunny Island 5048U can function as a stand-alone battery-based inverter or integrate with Sunny Boy inverters to create an AC-coupled system.

Courtesy www.sma-america.com

Exeltech inverters have very clean sine wave forms, but do not include battery chargers.

Courtesy www.exeltech.com

No-Load Draw. This is the power used by the inverter just to keep running when there is no load. No-load draw can be surprisingly high in some models (up to 30 W). Since there may be long periods of time when no power is required by the loads, this can add up to a substantial energy drain on the system. For instance, an inverter with a 30 W no-load draw will consume a minimum of 720 Wh daily. On small systems, this load can have a significant impact, especially in the winter when solar-made energy is at a premium.

Search Power. Most off-grid inverters have a power-saving feature called "search" or "sleep" mode to power down the high-energy-use components of the inverter when there are no loads on. Search mode also requires power, but much less than the no-load draw. In this mode, the inverter periodically tests the circuit for active loads and powers up only if a load is detected. But homes that have continuously running AC loads (like a telephone answering machine's 2 W wall cube) are unable to take advantage of this feature and are stuck with a minimum of the no-load draw. Some off-grid homeowners will strive for always-on loads to be DC-powered to allow their inverters to spend more time in energy-conserving search mode.

Battery Charger. Many off-grid inverters have an integrated battery charger that can be used to charge the batteries from an AC source, such as an engine generator. This feature negates the need for a separate external battery charger. Having an integrated charger is especially helpful during periods when an RE power source cannot keep up with household loads, such as during the short and often cloudy days of winter. The battery charger is also used to "equalize" batteries by giving them a controlled overcharge, making sure that even the weakest battery cells are occasionally brought up to full.

Chargers are usually rated in DC amps, but may be stated as AC amps, so read the documentation carefully. In the table, AC battery charger maximum current has been converted to DC amps.

Battery Temperature Sensor. The internal resistance of a battery increases as temperatures drop and decreases as temperatures rise, affecting battery voltage. At a given charge rate, at low temperatures batteries can get undercharged and at high temperatures they can get overcharged. To properly charge batteries where the temperature strays from the ideal 77°F, a temperature sensor provides data to the charger so it can adjust the voltage set points for higher and lower temperatures.

Generator Start. Some inverters can start and stop a generator based on several criteria, such as battery voltage, battery state of charge (SOC), load draw, and time of day. Generators can have either a "two-wire" or "three-wire" start mechanism. A two-wire start refers to two positions—on and off—and requires only a simple relay and a signal from a controller in the inverter/charger.

A three-wire start—a crank position, run, and stop—is more complex. There may also be pre-crank and other settings, as needed for diesel engines. Facilitating a three-wire start usually requires a separate controller from the generator manufacturer. Typically, inverters that advertise automatic generator start can be assumed to provide only the signal for a two-wire start. (For more information, see "Engine Generator Basics" in *HP131*.)

Metering. Several inverters offer metering as an optional accessory. Metering can provide helpful information about the system, including battery voltage (lets you know if the battery

Courtesy www.apollosolar.com

The Apollo TSW series inverter, with charge controller and breaker panel, comes in 24 V (3,200 W) or 48 V (3,600 W) versions.

Courtesy www.outbackpower.com

OutBack Power Systems offers components to put inverters, charge controllers, and other required balance-of-system components together in one neat installation.

is being charged or discharged), AC load amps (indicates the size of the AC loads), battery charging amps (from the AC power source), and even error codes (helpful for inverter troubleshooting).

With programmable inverters, the meter is often also a user interface for controlling other functions, such as turning the inverter on/off, starting a generator, or adjusting battery charger settings.

Remote Display. Usually the inverter is installed away from living spaces, and remote metering allows users to easily monitor their systems from a location away from the balance-of-system components. Often, remote displays show various other system metering details and have a switch to shut off the inverter. Aftermarket meters are available that can supplement the information available, like provide accurate battery SOC readings.

Integrated System Components Available. Some inverters can be part of packaged systems to ensure that individual parts—such as metering, charge controllers, and circuit breaker/disconnect boxes—work together and physically fit together.

Integrated system components offer a few advantages. First, the unit is engineered so the components fit together easily. Second, proper wire sizes are accommodated in appropriately sized boxes, and knockout holes that match up in the boxes and components. Often, a mounting plate that supports the whole system and provides the layout for the components is included. These systems can be prewired by the factory or distributor to meet the specific needs of an installation—all the installer needs to do to the integrated components is properly wire the inputs and outputs.

Electronic and communications integration can optimize operations such as battery charging and load support, eliminate the duplication of sensors (such as battery temperature sensors for both charge controllers and inverters), and provide a means for external data collection. A central control/meter can display system settings and data values, and simplify the user interface. Operations like generator start-and-stop controls can easily access needed parameters and data values, such as PV input, loads, and battery SOC.

Weight. Most of the weight of an off-grid inverter comes from the iron core transformer, which gives high surge capacity—an iron core can store energy for a few cycles, creating a flywheel effect to carry the inverter through surges.

If you are running only small electronics that have negligible surges, a lightweight inverter may serve you well. For instance, Exeltech inverters are very light, so they don't provide much surge capacity—yet they have a very fine waveform for finicky electronics, such as audio or telecommunications equipment.

If you are powering loads with high surges, like induction motors, seek a heavier inverter—and ensure that it is securely mounted to support its weight.

Warranty. Off-grid inverters are warranted against defects in materials and workmanship for up to five years, and extended warranties are sometimes available. Inverter manufacturers are typically quite responsive to addressing inverter failure and malfunction. Your installer or dealer can help with warranty problems and will be the initial contact.

ACCESS

"Solar Kelly" Larson is a NABCEP-certified PV installer and a licensed electrical contractor working in Mendocino County, California. Kelly has been teaching RE classes since 1996, and delights in simplifying complex concepts for students of all ages and abilities.