



Uninterrupted power supply (UPS) backup systems

Home power backup systems – electrical engineers answer your questions

The Conversation - Published: February 17, 2023 12.50pm SAST •Updated: February 17, 2023 3.27pm SAST. Authors: MJ (Thinus) Booysen Professor in Engineering, Chair in the Internet of Things, Stellenbosch University. Arnold Rix Senior Lecturer, Electronic and Electrical Engineering, Stellenbosch University

South Africa's electricity utility Eskom has made it clear that "loadshedding" – rolling scheduled power cuts – [isn't going to end any time soon](#). This reality, and President Cyril Ramaphosa's announcement during his annual state of the nation speech on 9 February 2023 that [tax incentives for solar power use](#) are imminent, mean that many people [are considering](#) alternative electricity supply systems for their homes.

But deciding on the best system isn't a simple matter. There's a bewildering array of jargon to sift through and many elements to consider, from the right kind of inverter to the size of your solar panels.

We are electrical engineers who are working on a standalone charger for small electric vehicles with the [South African National Energy Development Institute](#) as part of the [Long-Term Joint European Union - African Union Research and Innovation Partnership on Renewable Energy](#). The way the charger is designed resembles the sort of system needed for domestic power cut solutions. So, we're able to answer a few questions for those who feel overwhelmed by the options. Our full and detailed instructions for designing a loadshedding system will be available online soon.

What is an inverter?

This is a key component of any alternative power system. It's an electronic device that changes direct current (like energy stored in a battery) into alternating current (power for your home).

There are a few kinds of inverters. Some are grid-tied (synchronous) with Eskom's power grid. They are typically used with solar systems that augment the Eskom supply. But they are not suitable for loadshedding solutions.

You also get off-grid (grid-forming) inverters, which form their own mini-grid and can operate during power cuts.



An inverter system will look something like this. Suranto W/Shutterstock/Editorial use only

We recommend a hybrid inverter, which can be grid-tied to augment supply and seamlessly continue operation as an off-grid solution during loadshedding. You want a hybrid inverter that can connect to the grid, battery backup, and to solar panels. To extract the maximum power from the solar panels, be sure to get one that has maximum power point tracking (MPPT).

What size should the system be?

This purchase should be a long term investment. The inverter must be able to carry the sum of all the loads that are drawing power at any instant in time and the battery must be able to supply the energy required.

To reduce both the upfront capital cost and operational expenditure, you need to decide what is essential. Lights? Your washing machine? The stove and electric kettle? Then you need to make sure they are as energy efficient as possible before you size the backup system. For example, old incandescent lights use ten times more energy than LED lights do.

This table lists a few typical household items and their power consumption.

Why do I need batteries for my system?

It is theoretically possible for an inverter to generate electricity for household use directly from solar panels. But the supply from panels is intermittent and often not powerful enough to reliably supply power to the varying loads in the house.

To overcome this problem, energy is stored in the batteries. This provides a more stable source of power which responds to demand during loadshedding.

Battery capacity is specified as kWh (kilowatt hours) or Ah (ampere hours). This determines the amount of energy it can supply. A battery with a capacity of 5kWh can theoretically supply 5kW for an hour. But if a lithium battery is discharged beyond 20% of its capacity, it loses capacity and ages faster. A 5kWh battery therefore has an effective capacity of only 4kWh. It can supply 4kW for one hour, or 1kW for four hours.

As a practical example, if you want to power only 20 10W LED lights and a medium sized LED TV, drawing a total of 0.5kW, a 3.5kWh battery will suffice for four hours.

Are solar panels crucial for a backup system?

No. The batteries store energy to provide a stable supply to the inverter when needed. Technically, you can use the mains power to charge the batteries, rather than rely on solar panels. Solar panels are merely there to augment the supply of electricity and could give you a bit more range during loadshedding if the sun is shining.

But if everyone installs backup systems without solar panels, we are just using batteries to carry us through power cuts. That increases the load on Eskom outside loadshedding periods, as the batteries must be replenished. This will neuter Eskom's ability to use

loadshedding as a grid management tool. It could [destabilise the grid and lead to a complete blackout](#).

And if, [as is expected](#), the finance minister introduces tax breaks for solar generation expenses in the budget speech on 22 February, solar panels will have to be part of your setup if you want to benefit from these incentives.

No matter what Enoch Godongwana announces, we think this is a good time to make the switch to a solar powered backup system, for your peace of mind and future savings.

How much does it all cost?

Inverter prices are falling as the market grows, and vary across suppliers. Inverters cost about R3,000 (about US\$165) per kW for bottom of the range, and closer to R7,000 (about US\$380) per kW for top of the range. Most households will get by with a 3kW to 5kW inverter, if its loads are managed well, costing between R9,000 (around \$US490) and R35,000 (about US\$1,915).

Lithium (LiFePO4) batteries also vary in cost but normally retail for about R5,000 (about US\$270) to R7,000 per kWh. Most households will get by with a 5kWh to 10kWh battery if the loads are optimised and managed well. So you're looking at a cost of between R25,000 (around US\$1,370) and R70,000 (US\$3,830 or so) for the batteries.

Solar panels tend to range from R8,000 (about US\$440) to R10,000 (around US\$550) per kWp (a measure of how high the panels' power output is). Again, they're not crucial, but are necessary if you want the system to pay for itself over time.

Can I install this system myself?

No, unless you're a certified electrician. The inverter needs to be installed into the distribution board and the cost will depend on how many of your circuit breakers need to be moved to the backup as well as how easy the solution is to install; installation typically ranges from R10,000 to R20,000 (just about US\$1100). The inverter must be approved by the municipality if you want to feed back into the grid. Installing the solar panels is separate, and costs vary widely.

.....

Disclosure statement

The authors do not work for, consult, own shares in or receive funding from any company or organisation that would benefit from this article, and have disclosed no relevant affiliations beyond their academic appointment.

Partners

Stellenbosch University provides funding as a partner of The Conversation AFRICA.

The Conversation is funded by the National Research Foundation, eight universities, including the Cape Peninsula University of Technology, Rhodes University, Stellenbosch University and the Universities of Cape Town, Johannesburg, Kwa-Zulu Natal, Pretoria, and South Africa. It is hosted by the Universities of the Witwatersrand and Western Cape, the African Population and Health Research Centre and the Nigerian Academy of Science. The Bill & Melinda Gates Foundation is a Strategic Partner.

////////////////////

There are affordable ways to use solar power to brighten up those load shedding days



Jackery power station. Image: Unsplash

Daily Maverick - By Malibongwe Tyilo - 19 Feb 2023

While fully off-grid solar power may be out of reach for most of us, there are more affordable ways to incorporate portable short-term solar products, as well as long-term partial solar installations to protect parts of your home from the effects of rolling blackouts.

A complete solar system covering all of one's needs might be the ideal solution when it comes to dealing with South Africa's rolling blackouts.

However, with those costing north of R200,000 for an average family home to go either completely off-grid, or perhaps grid-tied but dependent on solar energy for up to 90% of electricity needs, it's a solution that remains out of reach for most South Africans.

But with the range of options that are available, incorporating solar energy into one's home needn't be an "all-or-nothing" proposition.

Solar-charged UPS backup

Uninterrupted power supply (UPS) backup systems are already a popular option among many South Africans afflicted by load shedding.

Depending on use and size, these generally provide power for a couple of hours to longer, before needing recharging from the electricity grid. Many can also be recharged using solar energy.

For example, a popular UPS backup battery — the 518 watt-hour (Wh) Gizzu Power Station — which typically retails for around R8,000, also comes with the option to charge via solar energy. For another R4,200 or so, one can also buy a portable 90-watt solar panel with which to charge the battery.

Not only would this reduce the amount of electricity consumers buy from Eskom, but in the case of Stage 6 and Stage 8 load shedding, where there might not be a long enough charging interval between blackouts — or in areas that experience regular power outages in addition to load shedding — this provides another source of energy to charge the UPS.

Additionally, for consumers who enjoy camping and other outdoor activities where electricity supply might be limited, they would be able to travel with their UPS as well as a portable solar panel.

Similarly, other power stations — such as the slightly pricier Ecoflow River Pro at R12,000 for its 576Wh version, alongside the cheaper 288Wh version at R9,000 and the 720Wh model at R14,600 – also come with the option of buying a solar panel to charge the battery.

For the sake of clarity, neither this writer nor *Daily Maverick* is endorsing the Gizzu Power Station and the accompanying solar panel, as we have not tested it. The Gizzu, as well as other products mentioned, such as the Ecoflow and Jackery systems, are used strictly for illustrative purposes. We recommend shopping around to find the best possible deal for solar rechargeable UPS systems, as well as reading [our article on UPS systems](#) to work out the exact wattage that will suit your electricity needs.

Portable solar panel

“If you’re using a portable solar panel at home, perhaps on an apartment balcony, you just need to make sure that you’re able to place it somewhere where it can get at least four to five hours of direct sunlight,” says solar systems installer Kinesh Chetty, an energy consultant with a focus on solar (PV) energy systems, and a former director of the Maxx solar academy in Johannesburg.

In addition to ensuring that your portable solar panel gets enough sun, it is important to check its watt rating to get a sense of how long it might take to charge your battery, which will be affected by a number of factors.

For example, Gizzu’s 90-watt panel would be able to discharge a maximum of 90 watts per hour, while a panel with a higher rating would be able to discharge more watts and therefore charge faster.

The more premium brands such as Ecoflow and Jackery also offer a range of portable solar panels that, in addition to charging their UPS batteries, can also connect to one’s devices such as phones and tablets, enabling one to charge them directly from the solar panel.

Jackery’s portable 100-watt solar panel, which sells for R7,000 at a local retailer, can power two USB devices simultaneously, directly from the solar panel without the need for a UPS battery. It also claims to fully charge Jackery’s 500-watt UPS in eight hours, or four hours for the 250-watt UPS battery, “depending on direct sunlight and perfect conditions”.

All in all, depending on needs and brand, consumers can get an effective and fully portable solar power backup solution that lasts a few hours for between R10,000 and R20,000.

What is also important to remember is that the UPS backup can still be recharged using Eskom power if one prefers not to invest in a solar panel.

The entry-level inverter, battery and solar panel solution

These portable solar-powered UPS systems can also cost well above the aforementioned prices, the more powerful and fully featured they are.

For example, Ecoflow’s Delta Max, which is rated for 2016Wh, currently retails for between R40,000 and R42,000, and if consumers would prefer to use solar panels to recharge it, they

can do so using up to two of Ecoflow's 400-watt solar panels, which sell for R20,200 each, bringing the entire setup to just over R80,000.

However, at that price, consumers can look at installing permanent small-scale solutions that power a number of appliances and lights. Importantly, these would include professional installation of solar panels, an inverter and battery, rather than a DIY solution.

"If your budget only allows you to get something off the shelf, then sure, get products like the Jackery system or an equivalent... but I would say that once you have about R50,000, you can make the transition from a product to a turnkey engineered solution," says Chetty, noting that in such a case, "small-scale solar, when designed correctly, is affordable, and it can do what you want it to do, but the design brief is super critical".

Tempting as it may be to seek out a standard solution, he explains that for the same price, customers may need a completely different design. For example, he has had clients who need a solution that primarily covers just their home-office items such as Wi-Fi, computers, printers and lights, and others who own restaurants and who need to power multiple fridges as well as their computers and routers.

Depending on the wattage of each, an installer would work out how many panels you need, what kind of inverter you need, and what size battery you need for it to be effective.

Importantly, he recommends that customers avoid going to buy the parts themselves before they have spoken to an installer, as well as avoid buying lead batteries, but rather opt for the more reliable lithium batteries.

With regard to the more high-powered and premium solar rechargeable UPS systems, Chetty says "you can go and buy a Jackery and you can put your refrigerator and your lights on it, but as it is not a fully integrated system that is wired into your distribution board... it is not a long-term solution for what the future of South Africa holds for the next few years in terms of energy security.

"At that R50,000 price, I would definitely recommend investing in a small-scale solar power system that is compliant in terms of installation, has the best materials and that can last for at least 10 years." **DM/ML**