

Gordian

Logistic Experts



July 2022



Loadshedding *who?*

Planned maintenance helps to keep the equipment in running condition while also reducing the risk of costly downtime. Planning for such maintenance is common practice. Materials used for industrial equipment are often unique, expensive, and timely to source. But what happens when a fault occurs unexpectedly between maintenance schedules? Downtime can cost a company tens- or even hundreds-of-thousands of Rands. During these events, spares are critical to restoring productivity in a timely fashion and minimising loss.

Critical parts are incredibly expensive and carrying critical stock can increase the company stock value by millions of Rands. And yet, it is necessary to eliminate costly downtime. Carry too much stock can tie-up valuable floorspace and even see expensive materials kept in unfit holding conditions. A balance is required between the investment into stock value and the resulting stock availability. Gordian Logistic Experts provide transparency for these complex questions, giving inventory planners the power to make more meaningful, comprehensive decisions for the future.

Much care is taken to reduce the overall risk of production lines. Sustaining productivity by minimising downtime is important to any company's turnover. But what about outside the production line? Working from home has become more commonplace since the Covid pandemic. According to Julien Raze, 63% of South African professionals have experienced an increase in their productivity while working from home [1]. Unfortunately, this has become rather challenging with the gradual increase in loadshedding instances (power outages) experienced across the country. Stage 2 or higher loadshedding can easily leave you stranded without power or Wi-Fi for 2 – 5 hours of the working day. This labour ultimately downtime is also detrimental, not only to the company but also to the employees trying to advance in their careers.



Objective – surviving loadshedding

Just as with spares and consumables, it is important to minimize downtime when working from home. Most South African’s will have heard about backup household power, but most citizens have no idea on what to pick or choose for their own living/working conditions. This paper will help you to understand the basics of backup power and answer the question of what is best suited for your own needs.

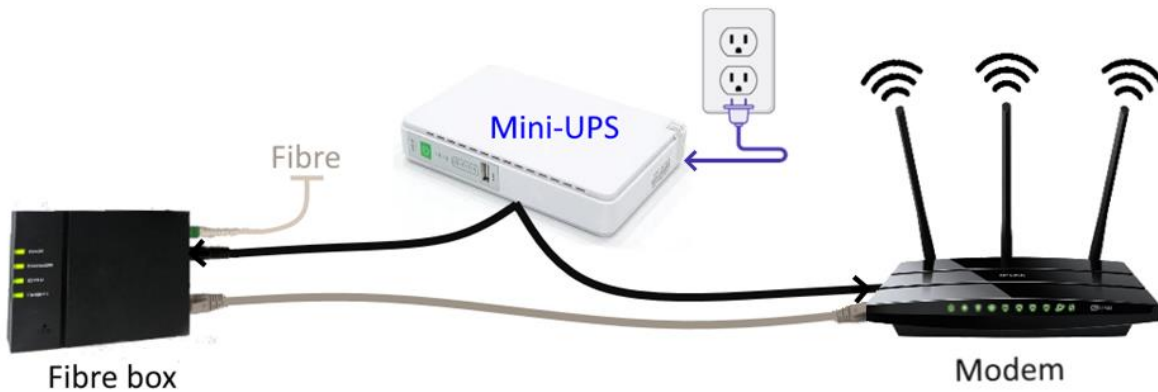
Staying connected – Wi-Fi / Internet

Let us assume that you are working at home on a laptop. The power goes out and, with a full battery, your laptop can last the two and a half hours until Eskom turns the power back on. However, your Wi-Fi disappears, and you are either forced to work offline or use expensive mobile data to stay connected. You simply want a solution to keep the household internet available during loadshedding. The easiest, and most affordable fix for this is to use a Mini-UPS.

In simple terms, a Mini-UPS is backup power (battery) for your modem. Instead of plugging your modem directly into the wall plug, you use a power-out cable from the Mini-UPS to power your modem. The Mini-UPS is then plugged into the wall. When the power is on the Mini-UPS will charge while simultaneously powering the modem. When the power trips the Mini-UPS continues to provide power to the modem (uninterrupted). The battery capacity of the Mini-UPS will determine how long the modem can be kept running.

Mini-UPS battery capacity	Expected backup power for 1 attached device
8 800 mAh	Up to 4.5 hours
10 000 mAh	Up to 6 hours
12 000 mAh	Up to 7 hours
20 000 mAh	Up to 12 hours

Your standard modem will require a 12V Mini-UPS, which is common. Some Mini-UPSs (most often the 12’000+ mAH ones) will come with a very short splitting power output cable. In other words, the one power output cable has two ends which can each power a separate device (near to one another). This is great for keeping both your modem and your black fibre box powered during an outage. See the example diagram (figure) on the next page.



Here are some helpful tips:

- Always go for a larger battery capacity than you think. Anytime you drain more than 50% of the battery, you start to reduce the effectiveness and life-expectancy of the device. Spending the extra money once can give you more years of security with less stress.
- To power one router/modem, I recommend the 8 800 mAh Mini-UPS.
- If you plan to use one Mini-UPS to power both the modem and the fibre-line box, then I recommend the 12 000 mAh (as shown in the picture above).

Energy sources – Do I require alternative power?

If you require more than just Wi-Fi to survive the ever-growing pain that is loadshedding, then you will require an inverter capable of delivering sufficient backup power for your needs. Before we look at storing the power, let's discuss how you will charge it. A normal inverter setup will charge the batteries whenever there is power available from the grid. This means that the electricity consumed still reflects as per usual on your monthly electrical bill, with almost no increase (roughly +1%).

Another way to charge your backup power is using alternative power sources. Solar panels and wind turbines are becoming very popular for home use. A proper setup can both support you during loadshedding and reduce your monthly electrical bill. However, the initial investment for these solutions can be very expensive and will take many years before you start seeing a return on the investment. If you are interested, there are many options available to choose from. However, this will not be discussed in further detail here.





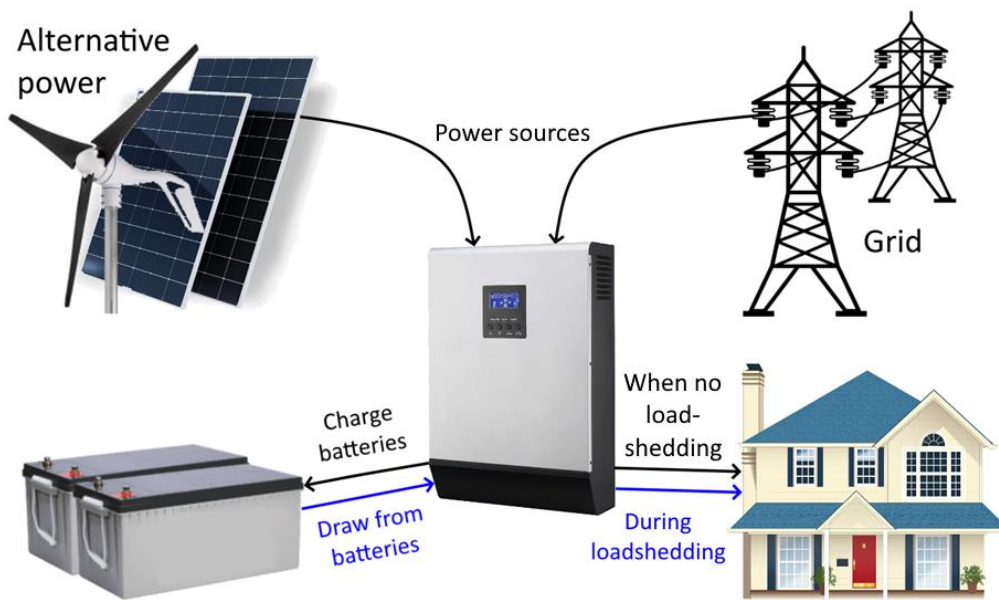
How does it work?

Regardless of which energy source you choose, you require the following to be covered during a power outage:

1. Batteries (to store energy)
2. Inverter (to charge the batteries and create power for your home): An inverter converts the direct current (DC) drawn from the batteries into alternating current (AC) used throughout the house.

Smaller inverters (< 4000 VA) are not ideal for wiring into the mains of your house. These inverters simply plug into a wall plug to charge, easy. Larger inverters (like the ones used for solar power systems) are most often installed into the mains of the house by professionals. The inverter will charge the batteries when power is available. During a power outage the inverter will draw stored energy from the batteries and convert it to AC for everyday use. Some good to know tips:

- The inverter must be turned on in order to produce power.
- If the inverter is turned on before the power outage, then the inverter will automatically switch from drawing power from the mains to drawing from the batteries. There is a small latency, but it is so short that your devices (modems and computers included) will remain running uninterrupted.
- Try to only turn your inverter on before (or during) the power outage and turn it off once the power outage is over. This will drastically increase the lifespan of the inverter.
- The inverter will still charge the batteries when turned off.





Which inverter do I choose?

We all want to go about our day as-if power outages do not exist. This is unlikely going to happen without alternative power. If you want to run your TV, computer, and a few lights then the load (amp and voltage draw) experienced by the inverter is low. However, if you want to run a heater, the oven, or your power tools then the load is substantial. We will now walk through 3 steps to determine your requirements.

Step 1 – What is your power requirement?

First you need to determine the total power requirement (Watts) that will suit your needs. The actual wattage for your device should be labelled somewhere on the appliance, but for a frame of reference I have stated some common household items and their typical power specification below:

Item	Power usage
LED lightbulb	4 – 18 Watts
CFL lightbulb	11 – 42 Watts
Incandescent lightbulb	60 Watts
Computer (idle – load)	50 – 150 Watts
Gaming computer (idle – load)	50 – 450 Watts
LCD computer screen (19" – 30")	20 – 50 Watts
Laptop (basic – heavy work)	40 – 120 Watts
Cellphone charger	20 Watts
Modem/router	10 Watts
Fan	55 Watts
Fridge	300 – 800 Watts
Chest freezer	200 – 400 Watts
LED TV (32" – 65")	30 – 90 Watts



For example, let's assume you want to be able to keep working from home during a power outage. You typically have your laptop (60W) and cellphone (20W) on charge. You use an additional 24" screen (35W). You don't have a Mini-UPS, so you want to power your modem (10W) and fibre box (10W) for internet. You use your desk lamp (12W) in the evenings and a fan (55W) during summer. Your partner working in the other room does the same (Total Watts x 2).

$$\text{Total power requirement} = 2 \times (60 + 20 + 35 + 10 + 10 + 12 + 5)$$

$$\text{Total power requirement} = 304 \text{ Watts}$$

Factor in more residents and the load grows further: gaming computer and screens, the TV, speakers, etc.

Step 2 – What VA rating should I get?

The volt-ampere (VA) rating is the voltage and current supplied by the inverter to the appliances. To determine the minimum VA rating of your inverter, you must divide your total power requirement by the inverter efficiency [2][3]. Most inverters will show you their “up-to” efficiency value. Always assume for the low efficiency moments. Standard efficiency is 60% (0.6). Let us assume your total power requirement is 1000 Watts.

$$\text{Min VA rating} = \frac{\text{Total power requirement}}{\text{Inverter efficiency}}$$

$$\text{Min VA rating} = \frac{1000 \text{ Watts}}{0.6}$$

$$\text{Min VA rating} = 1667 \text{ VA}$$

You always want to go for an inverter that can handle 20-25% more VA to supplement power peaks/surges. Therefore, our actual minimal VA rating is:

$$\text{Min VA rating} = 1667 \text{ VA} \times (1 + 0.25)$$

$$\text{Min VA rating} = 2083 \text{ VA}$$

Step 3 – Picking the inverter?

Inverters are sold in standard sizes. This inverter (shown below) is rated for 2400 VA with a standard efficiency of 60% (supporting up to 1440 Watts) and has a peak efficiency of 85%. This will work perfectly for our 1000-Watt load, providing a little extra for the odd additional device here or there. Always choose to be over-prepared than under-prepared.



However, this only answers the power-supply portion of our concerns. Without any batteries attached to the inverter, the inverter will have nothing from-which to generate AC power for your household.



Step 4 – Picking the batteries?

Let's not waste time discussing the types of batteries. For inverters, go for **Deep Cycle batteries** (also known as "marine/solar" batteries). Deep Cycle batteries generally have the highest reserve ratings and are specifically designed to withstand repeated drains of power and recharging. Deep cycle batteries should not be discharged below a 50% charged state (ideally, no less than **60% of the total capacity**). This may sound strict, but most other batteries should not be drained more than 80% of their total capacity and do not last long when repeatedly drained.

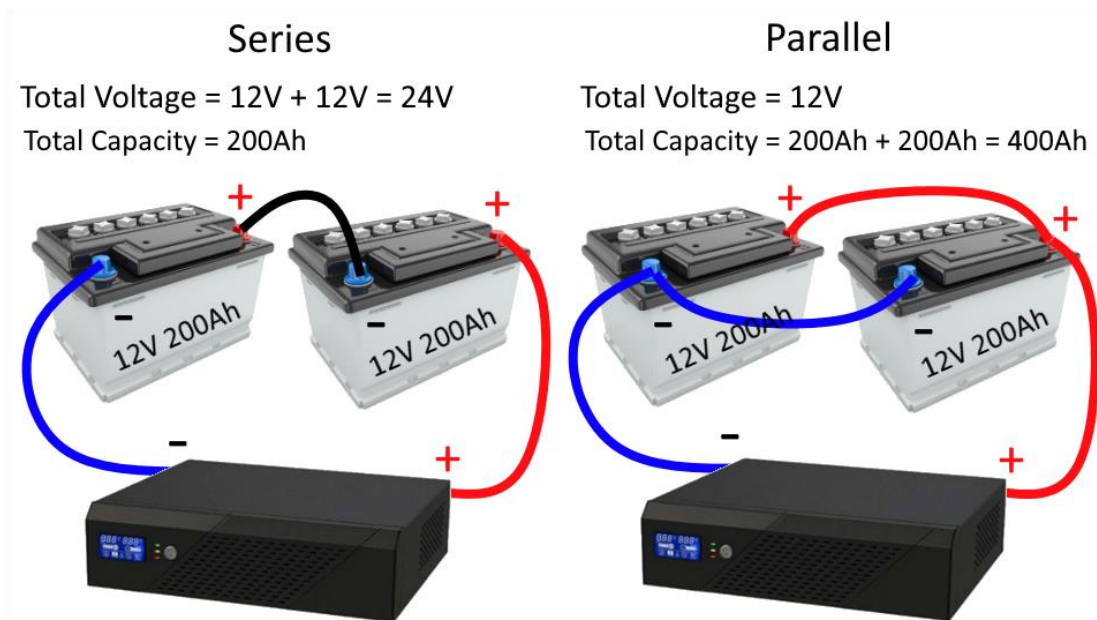
The inverter selected in Step 3 (previous page) requires a total battery voltage of 24V DC. All deep cycle batteries are direct current (DC), however most of them are 12V, not 24V. Therefore, in order to reach the 24V DC battery voltage required by the inverter, you will need to connect two batteries in series.

When batteries are connected in series:

- The voltage will add up, and
- The capacity will be the minimum of the set.

When batteries are connected in parallel:

- The voltage will be the minimum of the set, and
- The capacity will add up.





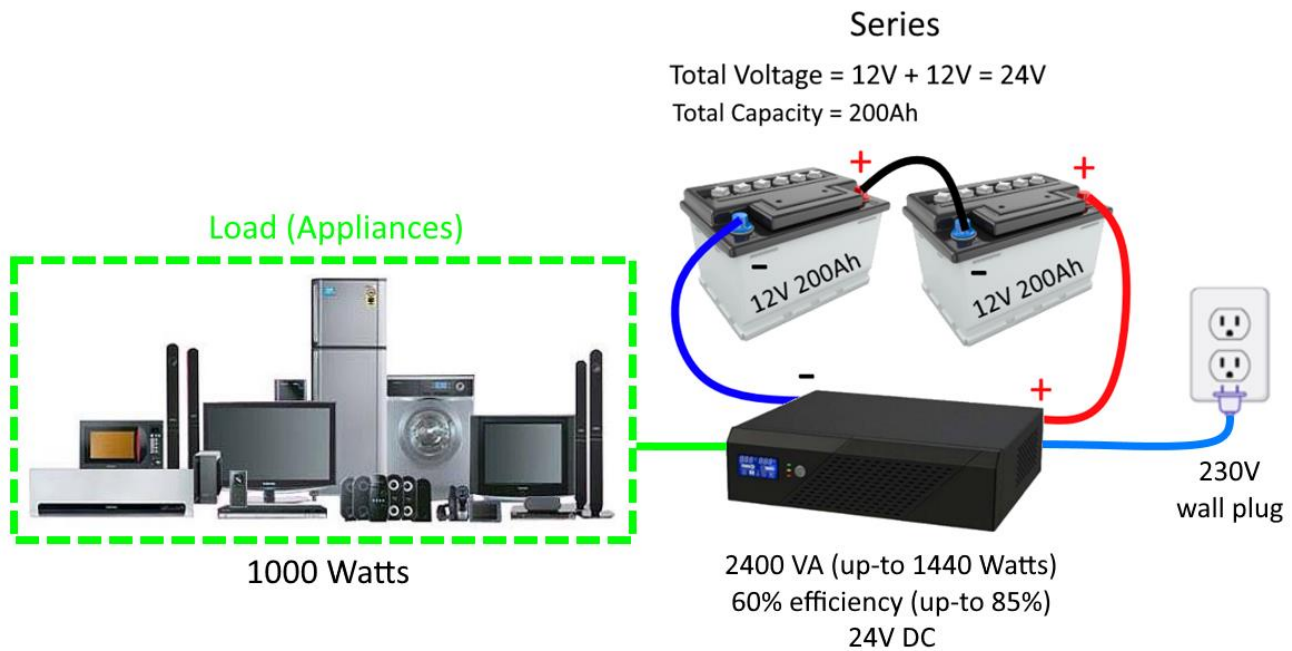
To calculate the minimum battery capacity (Ah) you will need to use the following formula [2]:

$$\text{Min battery capacity} = \frac{\text{Total power requirement}}{\text{Battery voltage (total)}} \times \text{Number of backup hours}$$

$$\text{Min battery capacity} = \frac{1000 \text{ Watts}}{24\text{V}} \times 4.5 \text{ hours}$$

$$\text{Min battery capacity} = 187.5 \text{ Ah}$$

Just like inverters, batteries come in standard sizes. In this case a 200Ah capacity makes sense. Most the time you will not be running at maximum load, and loadshedding will not exceed 2.5 hours. This means that the 200Ah suited for stage 6 loadshedding (instances as long as 4.5 hours), running at max load, is unlikely to often reach the 50% discharge. To summarise, see the figure below:



Money – Is it worth it?

Buying an inverter and two batteries can cost you a lot of money. Is it worth it? Let us assume that it will cost you R12'000 for all of the above. And let's assume you earn R150 per hour. Consider one month of Stage 2 loadshedding and assume that at least once during each working day you experience 2.5 hours without power (50 hours per month). This means that R7500 of your monthly worth (50h x R150/h) is compromised due to power outages. When you also consider that backup power will support the other members of the household, it becomes clear that the value-add is easily recognised within a short period of time. I hope this paper has helped you make an informed decision on reducing your own downtime at home.



References

- [1] J. Raze, "Dramatic increase in remote working in South Africa," 2022. [Online]. Available: <https://www.michaelpageafrica.com/advice/insights/latest-insights/dramatic-increase-remote-working-south-africa>.
- [2] J. Parmar, "Calculate Size of Inverter & Battery Bank," Electrical Notes & Articles, 2 10 2015. [Online]. Available: <https://electricalnotes.wordpress.com/2015/10/02/calculate-size-of-inverter-battery-bank/>. [Accessed 2 7 2022].
- [3] H. Synergy, "How to calculate the size of inverter needed for your home," Havenhill Synergy, 28 May 2018. [Online]. Available: [https://havenhillsynergy.com/size-inverter-need-home/#:~:text=2.,CALCULATE%20THE%20INVERTER%27S%20REQUIRED%20CAPACITY&text=Recall%2C%20the%20total%20power%20consumed,\(total%20wattage\)%20E2%80%93%20467W.&text=Therefore%2C%20required%20VA%20rating%20of,%2F](https://havenhillsynergy.com/size-inverter-need-home/#:~:text=2.,CALCULATE%20THE%20INVERTER%27S%20REQUIRED%20CAPACITY&text=Recall%2C%20the%20total%20power%20consumed,(total%20wattage)%20E2%80%93%20467W.&text=Therefore%2C%20required%20VA%20rating%20of,%2F). [Accessed 2 7 2022].