SA SUSTAINABLE ENERGY AND WATER GUIDE 2022

SA Home Loans

SECTION 1

SAVE ON ENERGY AND WATER

1. REDUCING CONSUMPTION: ENERGY AND WATER

1.1 Reducing electricity consumption

We are all seeing our monthly electricity bills rocket. What can we do about it, and is it worth the effort and cost? Let's look at some facts and figures and you can decide for yourself.

The cost of electricity has increased at a rate five and a half times higher than inflation over the past 15 years! Increased energy costs are squeezing already tight monthly budgets.

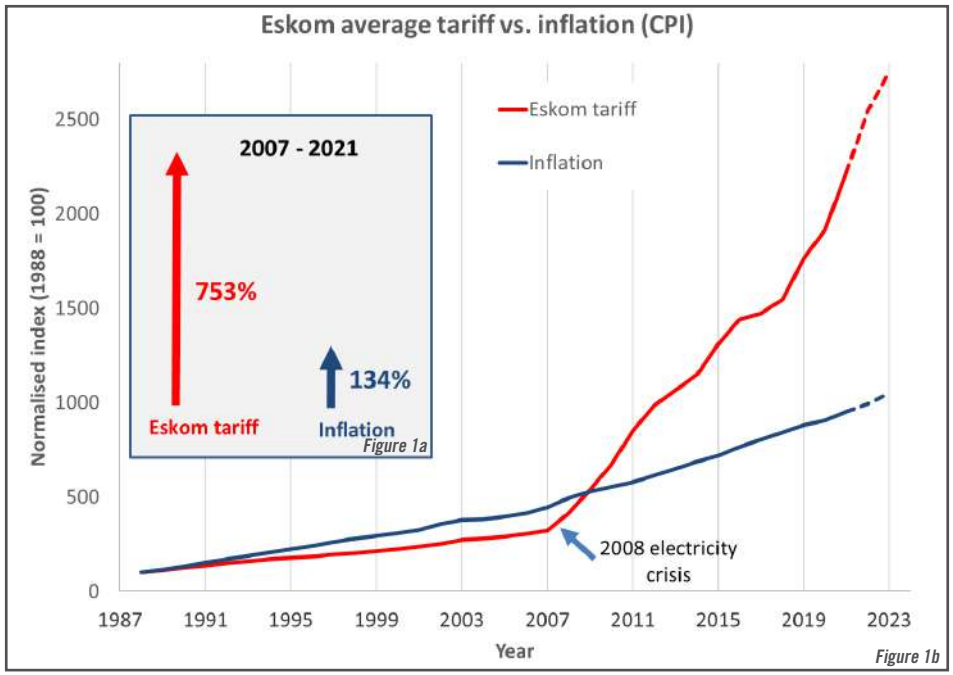

Figure 1a Eskom tariff increase from 1988 to 2021, compared with inflation (general price increases) over the same period
Figure 1b: Eskom tariffs from 1988 to 2021, plotted against CPI (Consumer Price Index) or inflation over the same period
(source: https://poweroptimal.com/2021-update-eskom-tariff-increases-vs-inflation-since-1988/)

It's predicted to get worse. If you look at the trend graph above, Eskom's runaway tariff increases started in 2008, when the red line steepens and leaves the blue line (inflation) behind. The dotted red line indicates further steep tariff increases.

Savvy homeowners are finding ways to cut their energy consumption. The easiest way to save is to switch off equipment, for example, lights, when they are not needed. Another way is to swop old inefficient technology for new energy-efficient technology.

We look at lightbulbs and geysers in more detail. Light bulbs because they're one of the easiest ways to save and geysers because heating water is generally the most expensive use of energy in a home.

a) Changing Light Bulbs. Is it worth it?

Yes! Yes! Yes!

We estimate that over the same period of time, at the same tariff, and providing similar amounts of light, the three different light fittings **cost** the following:

Incandescent (normal light bulb): **R182.21**

Compact Fluorescent Lights (CFL): **R54.66**

Light Emitting Diodes (LED): **R21.26**

Even when the cost of buying the replacement bulbs is taken into account, the annual savings are impressive. The estimated annual **savings** by using CFL and LEDs compared to incandescent bulbs, including the cost of new bulbs are:

CFL **R72.55**

LED **R81.95**

Consider the saving if you change 20 lights to LEDs = R1 639 you can save in a year!

Incandescent light bulbs used to be the only option before Compact Fluorescent Lights (CFL) and more recently Light Emitting diodes (LED) were developed.

LED lightbulbs are far superior to CFLs and incandescent for the following reasons:

- LEDs require much less wattage for the same amount of light (lumens). For example, the number of lumens from a 60 W incandescent bulb is equivalent to 13-18 W from a CFL and between 5-10 W from a LED.
- LEDs will last longer. For example, the average lifespan of a LED is 25 000 hours compared to 8 000 hours from a CFL and 1 200 for an incandescent light bulb.

Table 1 shows a direct comparison between incandescent, CFL and LED bulbs over a year. The power ratings for each bulb have been used with a running time of 4 hours per day. An average electricity price of R2.08 has been used for the simulations.

	Incandescent	CFL	LED
Power rating (W)	60	18	7
Hours operating (hrs)	4	4	4
Tariff (Rands)	R2.08	R2.08	R2.08
Daily energy consumption (kWh)	0.24	0.072	0.028
Annual energy consumption (kWh)	87.6	26.28	10.22
Average price for a bulb (Rands)	R49.00	R55.000	R79.00
Annual Electricity price (Rands)	R182.21	R54.66	R21.26
Potential Annual Saving (Rands)	-	R127.55	R160.95
Annual Savings including Bulb Cost (Rands)	-	R72.55	R81.95

Table 1: Comparison between incandescent, CFL and LED light bulbs showing costs and savings in electricity spend

If you have downlighters in your home, replacing halogen fittings with LEDs can save you R136.66 in electricity per year, or R67.66 if the cost of the replacement bulb is taken into account.

Multiply that annual saving by 10 lights by 5 years = R67.66 x 10 x 5 = R3 383 – and that's at a constant tariff!

Table 2 below shows a comparison between a 50 W downlight, and the replacement 5 W LED downlight running for 4 hours and charged at a R2.08 tariff.

	Halogen	LED
Power rating (W)	50	5
Hours operating (hrs)	4	4
Tariff (Rands)	R2.08	R2.08
Daily energy consumption (kWh)	0.2	0.02
Annual energy consumption (kWh)	73	7.3
Average price for a bulb (Rands)	R56.50	R69.00
Annual Electricity price (Rands)	R151.84	R15.18
Potential Annual Saving (Rands)	-	R136.66
Annual Savings including Bulb Cost (Rands)	-	R67.66

Table 2: Comparison between 50 W halogen downlights and 5 W LED downlights showing costs and savings in electricity spend

Changing all the light bulbs in your home to LED is an excellent place to start saving. LED bulbs are widely available at home and building supplies stores and all types of light bulbs are now available.

b) Geyser Options

Hot water is the single most expensive commodity in the home when it comes to energy. On average, 40% of our household energy consumption and electricity bill is for hot water. With the price of electricity soaring, interest in different energy-saving technologies is increasing just as fast. We share our research to show which options will give the best savings.

i) Are heat pumps better than geysers?

Research has shown that heat pumps are far more efficient at heating water than your traditional geyser, gas geysers or solar geysers.

A heat pump can convert one unit of energy into four units of heat energy, whereas a geyser uses three units of energy to produce three units of heat energy.

Heat pump: 1 unit of energy -> 4 units of heat energy

Geyser: 3 units of energy -> 3 units of heat energy

The reason for a heat pump's efficiency is that most of the energy used by the heat pump to heat water comes from heat absorbed from the outside air and is transferred to the water via a heat exchanger. It is possible to save between 60 -75% of hot water costs when compared to a standardgeyser.

Table 3 shows a power consumption comparison with a running cost comparison. There are advantages and disadvantages to using the different technologies.

	Heat Pump	Gas Water Heater	Electric Water Heater	Solar Water Heater
Energy resource	Air, electricity	Gas	Electricity	Solar, electricity
Transfer factor	860 kcal/kWh	24 000 kcal/m3	860 kcal/kWh	860 kcal/kWh
Average efficiency	4.6	0.8	0.95	2.7 (1/3 weather need auxiliary heater)
Consumption	10 kWh	2.08 m3	48.9 kWh	17.5 kWh
Running cost	7.7	50.2	36.7	12.8
Advantages and Disadvantages	Green, safe, energy saving, environmentally friendly and easy to install	High risk, danger of fire and explosion. CO2 emissions.	Risk of electric shock. Highest energy consump-tion.	Difficult installation, large area required, effective tank volume limited. Weather dependant.

Table 3 Notes:

- Power consumption comparison figures based on the same conditions to heat water from 15º C to 55º C.
- Average efficiency = ratio of output energy relative to 1 unit of input energy. The higher the ratio, the more efficient. For example, a heat pump generates 4.6 units of heating energy from 1 unit of energy. A standard geyser generates 0.95 units of heating energy from 1 unit of energy.
- Green shading indicates 'best' scores.

The easiest way to install a heat pump is the retrofit option where the geyser is used as a storage tank and the heat pump heats the water. The geyser element can be switched off but left in the tank as a backup if needed.

It is important to get the installation done by an accredited professional. This will allow warranties of all parts to remain intact.

ii) Solar geysers

Solar geysers use radiation from the sun to generate heat. The size of the panel or collection tubes will determine the quantity of energy harnessed from the sun.

For example, if a 3 m2 solar panel is connected to a 150 L geyser, it can provide 150 L of 60° C water by the end of a warm sunny day.

There are two downsides to solar geysers worth considering:

- On cooler days with less sunshine, the solar geyser might only be able to provide 35° C water. Solar geysers' performance is dependent on sunshine. In the example above, electric elements would be required to heat the water to 60° C.
- Another issue is the timing of the hot water. If one showers in the evening using hot water, the replacement water will not have a chance to heat up by the morning. Again, the element would be needed to heat the water to a usable temperature for a morning shower.
- Unfortunately, in South Africa, most solar geysers are undersized and will provide much less than the average 50% saving on your heating bill with solar geysers. Table 3 shows the efficiency between solar geysers, electric heaters and heat pumps.

iii) Cost estimates

A cost comparison of the different water heating technologies shows that heat pumps are a medium-term investment

Compared with a conventional geyser, buying and installing a heat pump is more expensive. Over the medium term, however, the savings from the lower electricity usage will bring a better return on investment. You will see consumption savings from the first day of installation.

Technology used	System size	Approximate cost including labour and installation (incl. VAT)
Conventional geyser	150 L 400 + 600 kPa	R 9 980
Solar geyser	200 L Geyser	R 21 357
Gas geyser	20 L Gas Geyser	R 15 212
Heat pump	5.5 kW	R 34 490

Table 4: Water heating technology costs.

iv) The right size geyser

Most modern geysers have a 100, 150, 200 or 250 litre capacity. Generally, they are 'renewable energy ready' meaning they can be retrofitted to heat pumps or solar thermal heating panels.

Smaller geysers (100/150 litres) will require smaller heat pumps (±3.2 kW) and are best suited for only 2-3 people living in the household.

Bigger geysers (200/250 litres) require approximately 5 kW heat pumps and are suited for households of about 4-5 people.

Some houses can have 2 geysers which will then be sized as above.

c) Energy saving tips

Some other ways to save electricity on your hot water system can include the following:

- Insulate your geyser with a thermal blanket and ensure all your hot water pipes are insulated.
- Set your thermostat to 60° C and not any higher. Higher temperatures are unnecessary and waste electricity. Be very careful not to lower your geyser temperature too much as legionella bacteria could culture in your geyser. This is a bacterium that incubates at 42 ° C and can cause a specific pneumonia.
- Install your geyser as close to the area where hot water is needed as possible (bathrooms).
- Use cold water to wash hands instead of hot water.
- Install water-saving shower heads – reduce the amount of water use and subsequent energy used.
- Limit the use of appliances with an element.
- Tumble driers are notorious for using large amounts of electricity.
- When boiling a kettle, limit the volume of water to what you need, it allows the kettle to boil faster and use less energy.

d) Energy Audits

There are Energy or Utility companies that specialise in residential energy saving and can undertake an audit. The companies would typically monitor your energy consumption over 2 weeks, looking at how much energy you use and what appliances use that energy. This will provide a list of energy-saving opportunities that you can implement in your house for both water and energy.

1.2 Reducing water usage

There are many ways in which we can work towards the sustainability of water supply in our everyday lives. Becoming aware and breaking bad habits around the home can reduce your water usage and prevent the wastage of this valuable resource. The following are certainly not the only things we can do, but are some ideas to start with:

- Shower rather than bath as it uses less water.
- Adjust shower heads to low flow instead of normal.
- Add aerate filters to taps.
- Install high efficiency, or low flow toilets.
- Make sure dishwashers are full before using.
- Turn the water off while you are brushing your teeth or shaving.
- Don't wash dishes under running water, rather use a sink of water.
- Make sure you understand the settings on your washing machine to use the correct amount of water for the load size.
- Don't use toilets as dustbins. Flushing away facial tissues or sanitary products should be prevented.
- Always make sure leaky pipes or taps are fixed.
- If watering your garden, use harvested water and never water your garden on a windy day.

2. Rainwater Harvesting

A rainwater harvesting system entails the collection of rainwater for human use.

For as little as R6 000, you can set yourself up to always have some water at your home. Water is already scarce in many areas of our country and having your own supply can lessen the demand on stressed municipal water supply. You will also have some relief if the municipal supply is ever compromised or shut down for repairs.

2.1 How much water can be harvested?

A quick calculation is:

1 mm of rain on 1 m2 of roof = 1 litre of water

So, if your roof area is 8 m x 5 m = 40 m^2, 25 mm of rain equates to 1000 litres in the catchment area for that one rainstorm.

The amount of water you can harvest is determined by three factors:

1. The size of your **roof** catchment area
2. The amount of **rainfall** that your suburb gets in a year
3. The size of your storage **tanks**

The most common mistake is not having enough storage space. During a heavy downpour, most of the water will be wasted if the tanks are already full, or just too small to handle the volume.

2.2 Is it safe to drink rainwater?

Generally, harvested water is used as grey water to flush toilets, wash hands or other non-potable (drinking) purposes. It can be used for watering around the garden - irrigation systems, and as outside taps, for things like washing cars and filling swimming pools.

Harvested water needs to be filtered to a quality fit for drinking purposes as it mixes with soluble and insoluble materials from the surfaces it lands on. It can even collect dust and pollutants as it flows down through the air. Other contaminants include plants, fungi, and other organic materials as well as inorganic substances such as minerals, metals, chemicals, and even some water-soluble paints.

Please always consult a water treatment expert before drinking rainwater. If not treated properly it can make you very sick.

2.3 How a harvesting system works

For starters, you need a water tank of your choice. Normally the size of the tank depends on the amount of space you have at home. The 1000 L slimline tank is a good starting point and has a smaller footprint. This tank needs to stand on a solid base and be supported, to prevent it from collapsing and getting damaged. The tank is generally placed underneath or close to the downpipe.

Secondly, an initial pre-filtration is required to keep the leaves and bigger particles out of the tank.

A first flush diverter is a great add-on as it allows the water that is collected first - and is usually the dirtiest - to bypass your tank. Some changes in piping will be needed to re-route the gutters to your tank.

Now that the water can be collected in your tank, you need a small pump to pressurise the water so that you can use it. Depending on the amount of water you need, a 0.37 kW or a 0.75 kW pump will be the appropriate size. This gives you access to pressured rainwater when you need it.

Figure 2 shows the components of a standard rainwater harvesting system.

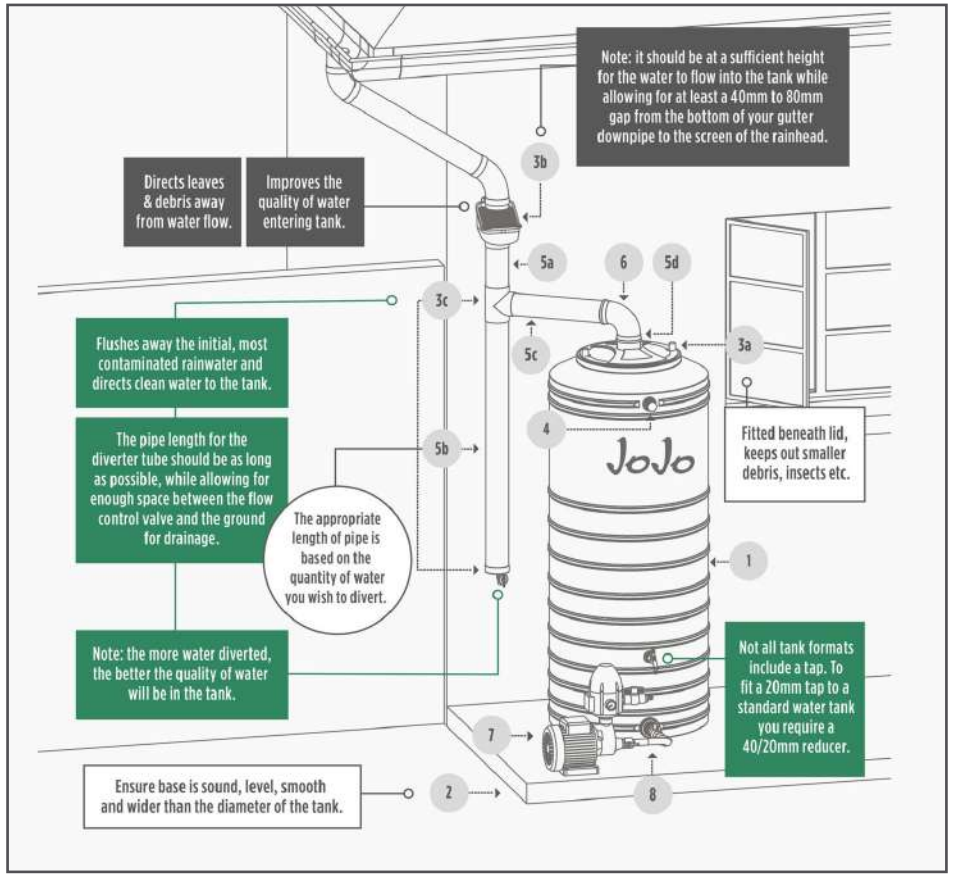

Figure 2: The system components of a rainwater harvesting system (source: https://www.jojo.co.za/water-storage-solutions/water-storage-solutions-rainwater-harvesting-above-ground/#)

2.4 Maintaining the system is simple

Maintaining the system is fairly easy and will prolong its life. Recommended maintenance checks include:

- Cleaning the rooftop regularly to avoid contaminating run-off. During the dry season, dust, leaves, dead insects and animal excrement accumulate on the roof. It's therefore a good idea to clean the roof before the rainy season starts. Cut back tree branches that overhang the catchment area.
- Ensure your gutters are free from leaves. Check the pre-filtration devices (first flush diverter, rain head etc) so that they are free from leaves and rainwater can pass through.
- Inspect your tank every 3-4 months to make sure no leaf litter and other plant matter have settled on the bottom of the tank. It may be a good idea to flush out your tank once a year and start afresh.

2.5 How affordable is rainwater harvesting?

Many tanks are available from different manufacturers such as JoJo, Roto tank and Eco tank. A 1000 litre tank can range from R2 500 to R2 850 depending on the manufacturer.

Booster pumps range from R1675 for the smaller 0.37 kW pumps to more expensive R10 249 pumps with variable speed drives and pressure control. Pre-filtration units (first flush diverters, screens etc can cost up to about R1000.

Plumbing fittings and piping should cost between R400 – R1 000 depending on pipe lengths and types of fittings, and taps required. The concrete plinth should cost about R600 for materials.

So, if you are a savvy homeowner and can build your rainwater harvesting system yourself… you should be able to harvest water and be able to use it in a simple installation for approximately **R6 000.** These prices will increase if bigger tanks are added and the grey water is plumbed into the toilets.

Prepare for Water and Power Outages

1. Loadshedding solutions

You can avoid the stop-start disruption load shedding has on your life by investing in an inverter and batteries, or a generator, or turn to the sun as a supplementary source of energy. The best solution for you will largely depend on your budget and what appliances you need to power during the planned outages.

1.1 Inverters and batteries

Basically, batteries store energy and inverters convert the stored energy into a current that appliances can use.

What is an inverter and how does it work?

An **inverter** is a compact, rectangular-shaped piece of equipment that is usually powered by either a combination of batteries linked together in parallel or by a single 12 V or 24 V battery. These batteries are usually charged by solar panels (in the case of a PV installation) or power from the municipality.

The function of an inverter is to convert Direct Current (DC) power into standard, Alternating Current (AC). This is because, whereas AC is the power supplied to industry and homes by the main power grid, the batteries of alternating power systems store only DC power. Almost all household appliances depend entirely on AC power to operate.

There are primarily two types of power inverters:

- 'True Sine Wave,' also referred to as 'Pure Sine Wave,' inverters and
- 'Modified Sine Wave,' also referred to as 'Modified Square Wave,' inverters.

Pure Sine Wave inverters have been made to replicate and improve the quality of power from the main grid. They are specifically recommended to power high energy-consuming electronic gadgets and equipment. Pure Sine Wave inverters are more expensive than Modified Sine Wave inverters and is the more powerful and efficient option of the two.

On the other hand, **Modified Sine Wave inverters** are much cheaper and are capable of running fewer household appliances and fixtures, for example - kitchen appliances, lights, and small power tools. However, this type of inverter may **not** have sufficient capacity to power high energy-consuming equipment and appliances such as computers, microwave ovens, air conditioners, heaters and laser printers.

Although more expensive, **pure sine wave inverter's** operational value is significantly more and they are preferred in most instances.

Please ensure connecting of inverters and changing wiring in an electrical panel or distribution board is only done by an electrician or a person qualified to do so.

A **battery** is a source of electric power consisting of one or more electrochemical cells with external connections for powering electrical devices.

The most common batteries are either Lithium Iron or Lead Acid/Sealed Lead Acid batteries.

The most notable difference between lithium batteries and lead acid is the fact that lithium battery capacity is independent of the discharge rate. So a lead acid battery cannot be discharged lower than about 30% without causing damage, whereas lithium iron batteries can be completely discharged without causing any damage.

The second notable difference is that Lithium has ten times the cyclic life of lead acid under most conditions. This brings the cost of lithium per cycle lower than lead acid meaning lithium can last longer than lead acid in cyclic applications. The nature of load shedding demands that batteries kick in frequently for a short period. This is the worst way to use a lead acid battery, but this type of usage does not harm lithium batteries.

The following graph shows the deterioration of the cycle life of Sealed Lead Acid batteries (SLA) compared with Lithium Iron (LiFePO4) over time.

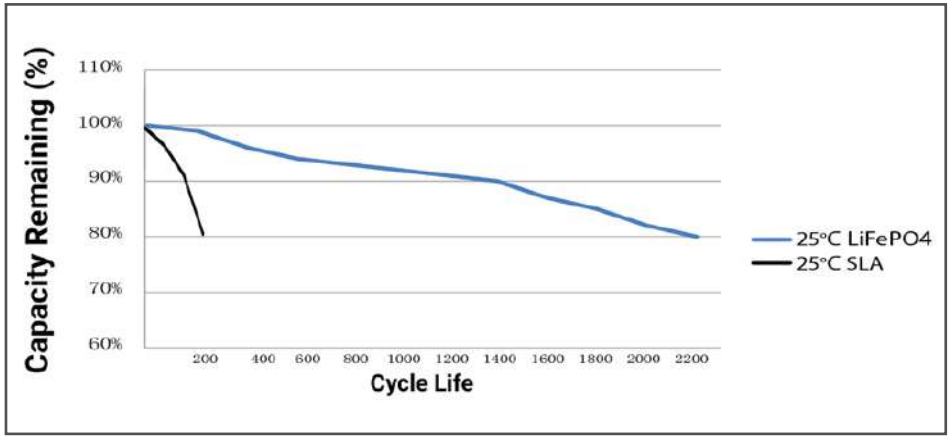

Figure 3: Cycle Life of Lithium Iron (LiFePo40 compared to Sealed Lead Acid Batteries (SLA) at 25°C (source: https://www.power-sonic.com/blog/lithium-vs-lead-acid-batteries/)

a) How much power do you need?

You can work it out, depending on whether you want to keep a few lights and the TV going, or still be able to do a load of washing.

The **size of the inverter** depends on the power (in Watts) or the current (in Amps) of the appliances and equipment that you would like to operate. This can usually be found on specification plates on the equipment (TVs, decoders, etc) or from the equipment operating manual. This important information is the continuous rating in Watts/Amps and the peak/surge rating in Watts or Amps.

Inverters are rated in both continuous and peak power:

- **Continuous power** is the Watts the inverter can supply indefinitely,
- **Peak power** is the power that can be supplied briefly usually on start-up.

Equipment with induction motors such as fridges, freezers, aircons, pumps etc sometimes have a start-up peak of 3-7 times the continuous rating.

How to convert Amps to Watts – multiply the equipment Amps x voltage (220) = Watts (approximate)

So, if you want to run an appliance with a continuous load of 5 Amps and a peak load of 15 Amps:

Power: 230 VAC x 5 A = 11 50 Watts continuous power

Power: 230 VAC x 15 A = 3 450 Watts peak/surge (also known as start or inrush power)

You would need an inverter with a continuous rating of approximately 1 500 Watts and a peak/surge rating of approximately 3 500 Watts. It is advisable to build in a safety factor by overrating the continuous rating by 20 – 25%.

The **size of the batteries** that you purchase depends on the time duration you wish to have power.

For example, a 7 Amp/Hr (A/H) battery can run

7 Amps for an hour, or

14 Amps for 30 mins or

3.5 Amps for 2 hours

Table 5 depicts some common household appliances and an estimated wattage with suggested batteries that are required.

	Power Requirements	Approximate Wattage	Recommended Batteries to use
1	TV for 13 hours	250 Watt	2 x 170 A/H
2	TV & DVD plus 1 light for 12 hours	350 Watt	2 x 170 A/H
3	TV & DVD & DSTV, plus 6 LED lights for 11 hours	600 Watt	2 x 170 A/H
4	TV & DVD & DSTV, plus 6 LED lights + Fridge for 5 hours	700 Watt	2 x 170 A/H
5	TV & DVD & DSTV, plus 10 LED lights + Fridge for 4.5 hours	800 Watt	2 x 170 A/H
6	TV & DVD & DSTV, plus 10 LED lights for 6 hours Plus occasional Microwave oven	1200 Watt	2 x 170 A/H
7	TV & DVD & DSTV, plus 10 LED lights for 6 hours Plus occasional Microwave oven Electric gate motor backup power	1200 Watt	4 x 170 A/H
8	TV & DVD & DSTV, plus 10 LED lights for 6 hours Plus occasional Microwave oven Electric gate motor backup power	2000 Watt	4 x 170 A/H
9	TV & DVD & DSTV, plus 10 LED lights for 5 hours Plus 2x computers for the same time	1500 Watt	4 x 170 A/H
10	More powerful house hold setup, such as 10 LED lights, TV, & DSTV, Washing machine 2.5 hours	3000 Watt	4 x 170 A/H
11	300 W for 12 hours	300 Watt	2 x 170 A/H
12	900 Watt for 4 hours	900 Watt	2 x 170 A/H
13	1500 Watt for 5 hours	1500 Watt	4 x 170 A/H
14	2000 Watt for 3.5 hours	2000 Watt	4 x 170 A/H

Table 5: Power consumption estimates for Specific equipment in your House

b) Costs for inverters and batteries

Inverters range in cost and can start from as little as R2 000. As the wattage capacity of the inverter increases, so the price increases. Each battery you need will be in the R6 000 to R8 000 range. This is a minimum amount. Battery prices can range way higher, so it's important to do research.

Start by deciding what equipment you want to run on the inverter and what the continuous wattage of each piece of equipment is. Add those all up and you will have the required continuous wattage of all the equipment. You can use Table 5 above as a quick reference. Remember to check if any of the equipment you want to run has a peak wattage specification, and factor this into your requirements.

It is advisable to have a qualified professional install the inverter and wiring to your chosen appliances to be run off the inverter system. There are many suppliers who sell inverters and they would be able to guide and assist you with your purchase

1.2 Generators

Another option to deal with load shedding is the installation of a generator or the use of a portable generator.

a) What is a generator?

In the event of load shedding or a power outage, a generator provides an alternate power source for your home. Depending on the type of generator you have and what your needs are, a generator can be used to power certain parts of your home, certain appliances or your whole home. There are two main types of generators, portable generators and standby generators.

b) Portable generators

These are typically smaller generators that are fuelled by petrol or diesel (manual fuelling). They can be used to run certain appliances within the home but typically cannot run everything. It is always wise to have a professional assist with how you will use your generator. Whilst a portable generator is not installed in your home, it is important that the distribution of the power it does generate is professionally installed.

A portable generator normally needs to be manually started and shut down in the event of use. Portable generators are more cost-effective solutions than standby generators for load shedding purposes. Portable generators can be bought from many different stores, from hardware stores to major chain stores.

c) Standby generators

These generators are backup generators able to power the house and engage automatically when the power goes out. It may take 20 – 30 seconds, but they will turn on automatically. These generators also come in different sizes, so you can source the generator you need.

Standby generators are typically the more expensive option, given the installation required and the fact that they can offer more backup. They must be installed by a professional.

d) Downside to generators

Noise and fumes are the biggest drawbacks. While there are silent generators available, generators typically do make some noise and so installation becomes important. They also need to be installed in areas where fumes do not build up. Quieter generators also often attract a higher price. Small fuelled generators make a substantial noise, which may be unpleasant to neighbours, yourself and animals.

Fuel prices are also a drawback for generators and the physical need to refuel the generator. Making sure you have fuel on hand so you never run out can become a nuisance.

1.3 Solar Solutions – for load shedding and reduced energy costs

Harnessing energy from the sun can save on your monthly bills. But it's important to understand how each of the solar systems work. Whether you choose a grid-tied, hybrid or off-grid system will influence how much power is available to you at what times and what the system will cost to set up.

The good news is that most of SA has a decent horizontal irradiation profile for solar panels. The bad news is that the sun doesn't shine every day and most households have a high demand for power when the sun isn't shining. But batteries and a link to the grid can get around those problems.

We've done the research and explain it in simple terms below, with cost estimates and finance options to help you figure out what's best for you.

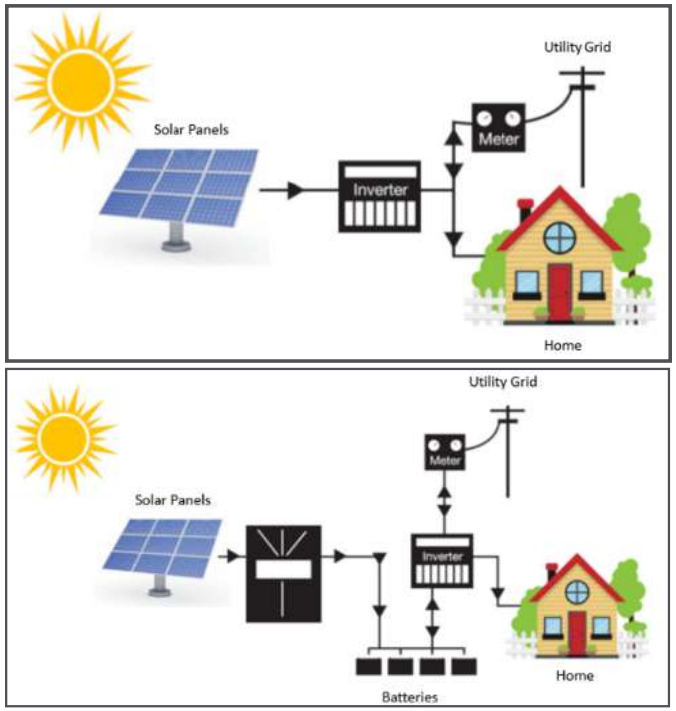

Figure 4: An example of A grid-tied solar installation (A) above compared to a hybrid solar system below (B) (source: https://www.magnet.co.za/solutions-solar/grid-tied-solar-solution.html)

a) Grid-tied or hybrid solar systems

Grid-tied solar, in which access to the grid is maintained and municipal power still available, is the most financially viable solar solution. In this system, energy produced by the solar panels flows seamlessly during daylight hours to supplement municipal usage. There is no battery storage and the power produced is consumed instantly.

Hybrid solar solutions combine grid-tied and off-grid with a municipal grid connection. Batteries that are charged by solar power are used to either be:

- Discharged in non-sunlight hours
- Stored for load shedding or power outage events
- Strategically timed as a combination of the two.

b) Grid-tied systems don't rely 100% on the sun

Grid-tied solar systems only produce maximum electricity when the sun is shining. Rain and bad weather will result in a greatly reduced amount of solar irradiation and less electricity being generated. This will result in more electricity being used from the municipality's supply.

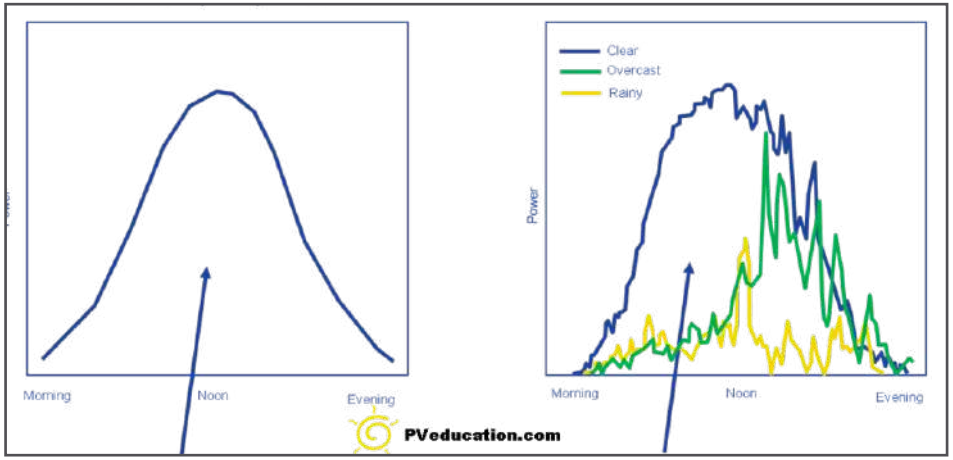

Figure 5: Solar system Output in an ideal weather situation (left) and clear, overcast and rainy weather situations (right) (source: https://pveducation.com/solar-concepts/solar-system-output/)

Figure 5 shows an **ideal** bell curve of solar power over a day (left). The right graph shows the **actual** power during clear, rain and overcast conditions. It is important to be aware of the actual variations and possibly shift loads. If activities like washing and drying can be shifted to days of better sunshine, it will help to maximise the solar savings.

c) How solar panels work

Photovoltaics (PV) directly convert solar energy into electricity. They work on the principle of the photovoltaic effect. When certain materials are exposed to light, they absorb photons and release free electrons. This phenomenon is called the photoelectric effect.

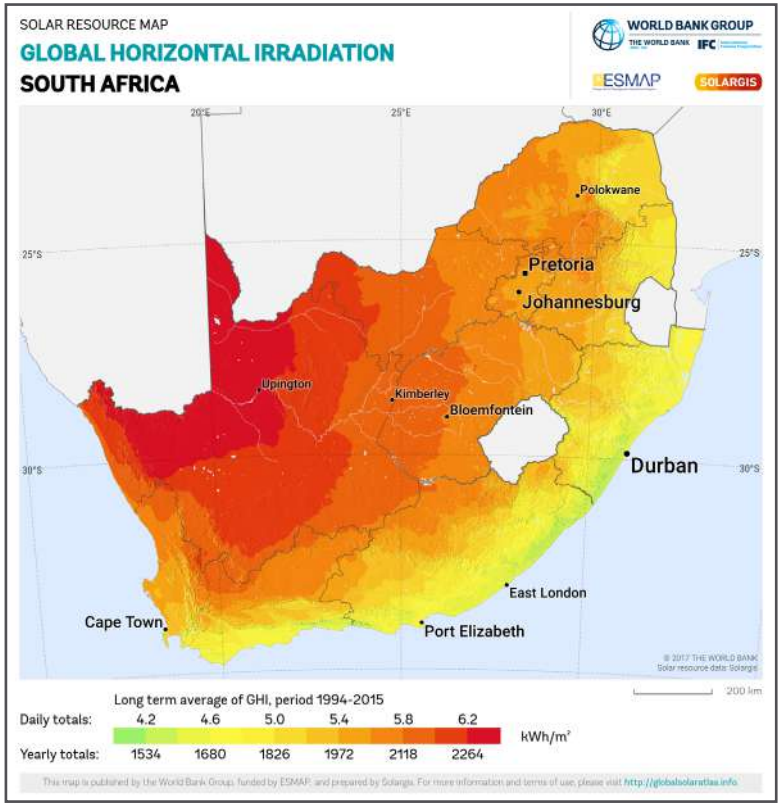

Figure 6: Global Horizontal Irradiation in South Africa (source: https://solargis.com/maps-and-gis-data/download/south-africa)

Solar irradiance is the power per unit area received from the sun in the form of electromagnetic radiation. It is measured in the wavelength range of the measuring instrument. Solar irradiance is measured in watt per square metre (W/m2) in SI units. The measure effectively tells us how much energy can be obtained from the sun per area. As you can see from Figure 6 showing irradiation levels, our country has a gradient from left to right, with the better levels on the left (Northern Cape) and decreasing toward the eastern coast. Although some areas are better, solar energy remains a clean available source of energy.

d) Roof space and panels

A rough guide for installing PV panels is you will require **10 m² for every 1 kW of power required.**

North-facing roofs are ideal in South Africa and if you can have a tilt of 25-30 degrees, that would be even better. North East and North West facing panels will also work.

Be aware of trees and shading on your panels during the day, as some trees could need trimming.

Most panels only require about 100 mm clearance between the panel and the roof structure itself. If you have a flat roof, there would be a fundamental change to the roof and the panels would need to be at an incline to optimise the sunshine yield.

In most instances, the panels can be installed without making holes in the roof. The installers use mounting brackets that clamp onto the beams.

e) Matching usage patterns with the sun's rays

On a grid-tied system, the solar energy generated during the day can only be used during that period. If you look at Figure 7, the green line and area under the curve represent the energy generated from the panels. The red line and area show the load of a domestic user for an average day. Energy demand represented by the red area from 17:00 onwards cannot be sourced from the sun and will have to come from the municipality. To optimize the solar energy, some activities using washing machines, geyser/heat pumps, hair dryers, could be used between 06:00 and 08:00 to improve the overlay of the energy load profile (red) and the power generated (green).

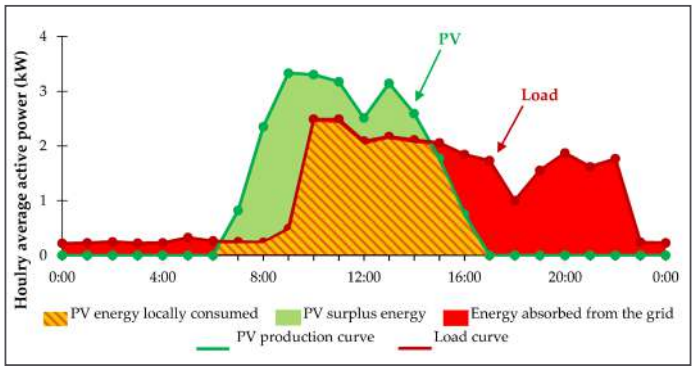

Figure 7: A Generic example of a PV generation and load profiles of a domestic user (source: https://www.mdpi.com/1996-1073/14/6/1591/htm)

f) Costs for grid-tied solar solutions

According to the country's solar experts, a grid-tied system can cost anywhere from R63 000 to R200 000, depending on the number of panels, available roof space, and electrical requirements (number of appliances, usage and lifestyle patterns).

Heat generating appliances such as geysers, stoves and heaters may require a much larger system with a higher price tag. Table 6 shows the sizing and approximate cost of systems based on how much you are spending on electricity each month.

Electricity Expenditure in Rands per month	System size	Approximate cost (incl VAT)
Below R1 300	2 kW	R63 000
Between R1 300 - R2 200	3 kW	R74 000
Between R2 200 - R5 000	5 kW	R110 000
Over R5 000	10 kW	R188 000

Table 6: The approximate sizing and costs for grid-tied solar systems compared to one's energy spend each month. Date: 2022

In standard commercial operating hours, you can expect a 30-50% reduction in your grid usage with a grid-tied solar system (load profile dependant).

g) Financing options

i. Rent-to-own equipment

Options to rent solar equipment are attractive to homeowners as they require limited or no upfront capital investment. There are no maintenance costs, no insurance costs, and you will save on your monthly electricity costs. But there will most likely be pre-qualification for finance, including age limits, gross salary income, debt review etc. These options seem attractive, but understand the fine print and the repayment terms very carefully. It may just be more beneficial and cheaper to pay for the equipment in full upfront.

ii. Purchasing your own equipment

Purchasing your own equipment is the best way to save money in the long term. There will be no finance costs and extra interest that you have to pay off. You can shop around for the brands you prefer and choose your own installers.

iii. Pay for generated electricity only

There is another option, currently only available to complexes, in which only the electricity produced is paid for.

It works as follows:

- The complex signs a power purchase agreement (PPA) with a solar company. This mimics the deal that Eskom has with independent power producers (IPP).
- Under this PPA the company installs the solar panels for free, subject to a long-term lease and agrees to a 'solar tariff'.
- These terms are normally about 20 years and have a take or pay clause where the client complies to pay for usage, or deemed usage, if the solar power produced cannot be consumed. If the site shuts down, or maintenance needs to be done, for example.

This model seems to work best with complexes with 50 units or more and a combined roof space of between 200 m2 to 400 m2. This can save the complex between 5%- 25% each month.

2. Water solutions

By storing municipal water in tanks, it's possible to manage your own water security and always have water available at home.

Water tank/s with a small pump are connected between the municipal feed from the municipality and the water pipe supplying the house. During normal operation, the water fills the tanks and the pump supplies water at a set pressure to the house. When there is no municipal water, the water in the tank is used.

Costs for this are similar to a rainwater harvesting system. Unlike rainwater which is free, the feed water is municipal and will need to be paid for.

Getting off the Grid

Imagine being in control of your energy and water supply and not depending on, or paying for, public utilities.

Sounds great!

The benefits of an off-grid solution are that you become completely independent from external energy supplies, you can avoid the spiralling increase in energy tariffs and, if you are very remote, you will save on huge grid connection charges.

But it's not practical for everyone. You will need space for solar panels and water storage. To make sure you have sufficient energy when you need it and water that's safe to drink, you will have to call in the experts.

1.1 Energy

a) What will it cost to go off-grid?

Depending on the size of the household, estimates are in the region of R250 000 to take a small house completely off Eskom's grid. This estimate is based on a house with 3-4 people who use approximately 25 kWh per day. The cost will obviously increase as the house gets bigger and the electricity demand increases. The need for greater battery capacity will increase the price of the off-grid solution drastically and should therefore be carefully considered.

b) Implications of relying completely on the sun

An off-grid solar system is not connected to the electricity grid. All the energy available to the home is from the solar system and available immediately via an inverter, or stored in batteries to be used when energy is needed. Even if you want to, there is no way to tap into the power grid. Which makes it critical that off-grid solar systems are designed to generate enough power during all four seasons and have the necessary battery capacity to meet the installed location's electrical demand.

Generally, off-grid solar system sizing or specifications are determined by two measures:

- Daily wattage usage and
- Peak watt-hour requirement.

As a rough guideline, daily watt-hour usage can be calculated from utility bills over a few months or a year. More accurate usage patterns can be monitored with energy metering data loggers. If you are going to invest in an off-grid solution, energy monitoring before system design is a non-negotiable 'must'. All good solar companies will want to meter your household electricity usage before designing a photovoltaic (PV) system.

Refer to how solar systems work

Tip: Don't waste good money on generating and storing electricity only to waste it through inefficiencies! Make sure that the house is as energy efficient as possible (LED light bulbs, heat pumps, etc Refer to reducing energy consumption) before you calculate how much energy you need.

c) Batteries are the Big Decision

Batteries will be one of the main costs of your off-grid PV system. The batteries used for off-grid systems are the same as those used for hybrid systems. The only difference is that off-grid will probably need far bigger batteries, or just more of the same batteries connected. To get up to speed on the debate between lithium iron batteries typically used to power electric vehicles, or lead acid batteries, generally found under the hood of conventional cars, refer to the battery section.

d) Usage patterns and lifestyle adjustments

Because 100% of your home's energy is being drawn from batteries, you may need to make small changes in usage patterns to prevent running out of power or damaging the batteries. Depending on how the solar system is designed, you may not be able to operate energy-hungry equipment like the geyser, oven, stove and kettle all at the same time. Refer to Figure 7)

e) Consider not going completely off-grid

Do the maths for yourself. To save costs on additional battery storage, it might make financial sense to keep the hybrid style of solar system. This maintains the electrical feed from the municipality, reduces the number of batteries you need and still cuts your electricity bill because you use some energy from the sun. It is also a useful backup, should there be an issue with the solar system, the municipality can supply your house and not leave you in the dark.

2. WATER

Going off the grid waterwise, there're two options:

- Rainwater harvesting
- Drilling a borehole

If you are lucky enough to have sufficient storage space for rainwater (i.e., ± 30 kl) or a borehole that yields a constant supply, a small water treatment plant can treat the water to a quality suitable for drinking purposes.

Refer to Section 1 on rainwater harvesting.

Water that doesn't come from the municipality must undergo testing at a qualified laboratory and meet the South African National Standard SANS241. Please consult a water treatment expert for advice and designs before drinking water from a source other than the municipality.

SA Home Loans

Cost estimates provided in the Sustainable Energy & Water Guide 2022 are approximate and valid at the time of publication.