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SUNNY SOLUTION

A REVIEW OF SOLAR-POWERED PUMPS

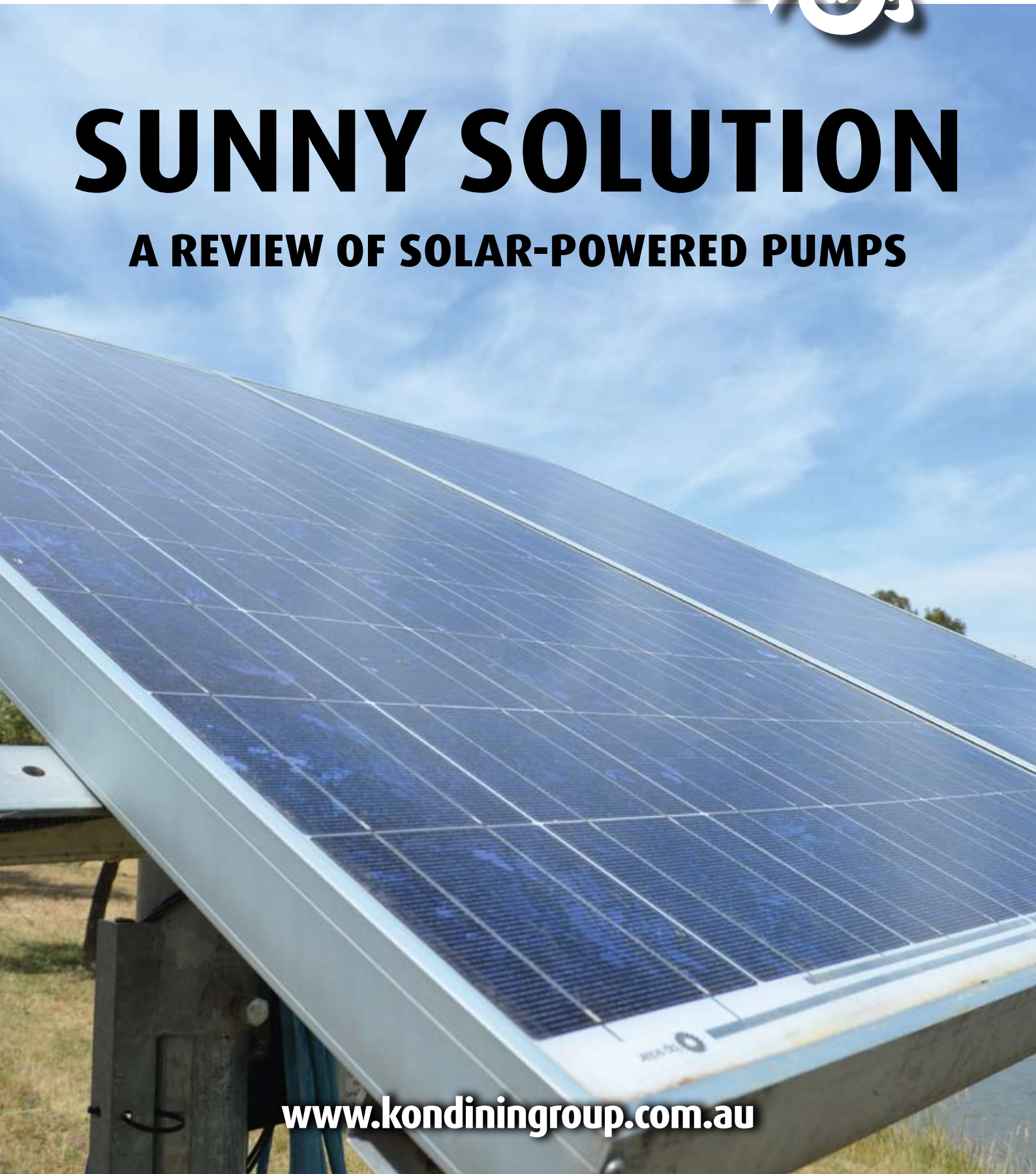

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Photo: Beth White

Sunny days: *The sun can provide a clean and efficient source of energy which can be used for many farm tasks including pumping water for livestock.*

Getting off the grid can be good

Kondinin Group researcher Mark Saunders has a look at how solar power can be used on farms

With electricity costs on the rise, solar-powered pumping may now well be worth a look, especially when it comes to important tasks such as watering livestock.

Since July 1, most states have seen electricity costs from "grid" suppliers go up and depending on the state in which you farm, those rises have been between 10 per cent and 18 per cent.

In the past five years, electricity costs in some capital cities have risen a whopping 50-60 per cent.

So it looks like high power costs are here to stay, which makes solar an even more attractive option.

It's a clean, efficient source of energy and the technology has been around long enough now to be tried and proven.

Solar power has historically been popular due to its availability in remote areas (where mains power availability is limited or non-existent) but the price hikes have many farmers and domestic users taking a closer look at energy supplied from the sun.

One of the largest retailers of solar power gear in Western Australia told Kondinin Group about 60-70 per cent of large farming stations in WA now have "off grid" solar-powered systems for domestic use.

These types of systems have battery, petrol or diesel-powered back ups but are definitely becoming more popular.

When it comes to solar power for pumping, installation costs start at $4000-$5000 for a basic system but you can spend anywhere up to $50,000 depending on the amount of water you need to move, storage tank capacity and the height the water needs to be raised.

Typically the system involves moving water from a source such as a well, bore or dam to a central storage such as a tank which then feeds stock troughs.

Filling a storage tank is the preferred method of back up, so if there is a break down, stock have a few days of supply just in case.

Plus water can also be delivered at night without having to rely on batteries and tanks can deliver variable volumes according to needs.

Another plus to solar-powered systems, especially when compared with the traditional windmill, is they are virtually maintenance free – and are located on the ground.

That's a big plus when it comes to safety and makes an attractive option for corporate farms or farms which rely on seasonal labour.

Before making the move to solar, there are several key factors which need to be considered, including stock water requirements and the quality of the water.

You also need to calculate the system head requirements and remember to include friction losses for various pipe sizes, fitting considerations and the total lift height. **FA**

At a glance...

- Solar-powered pumping systems have come a long way in the past decade with improvements in technology and the hardware required for the system
- Set up costs may be quite substantial but there are very few ongoing running costs and zero power input costs
- Recent electricity price hikes and advances in solar power systems technology have resulted in many farms looking at running "off grid" power for use on houses and sheds
- Solar-powered pumping for uses such as stock watering requires minimal maintenance and is a much safer option than windmills as it's all at ground level
- Basic solar-powered pumping systems can cost upwards of $5000 and pump up to 50,000L a day

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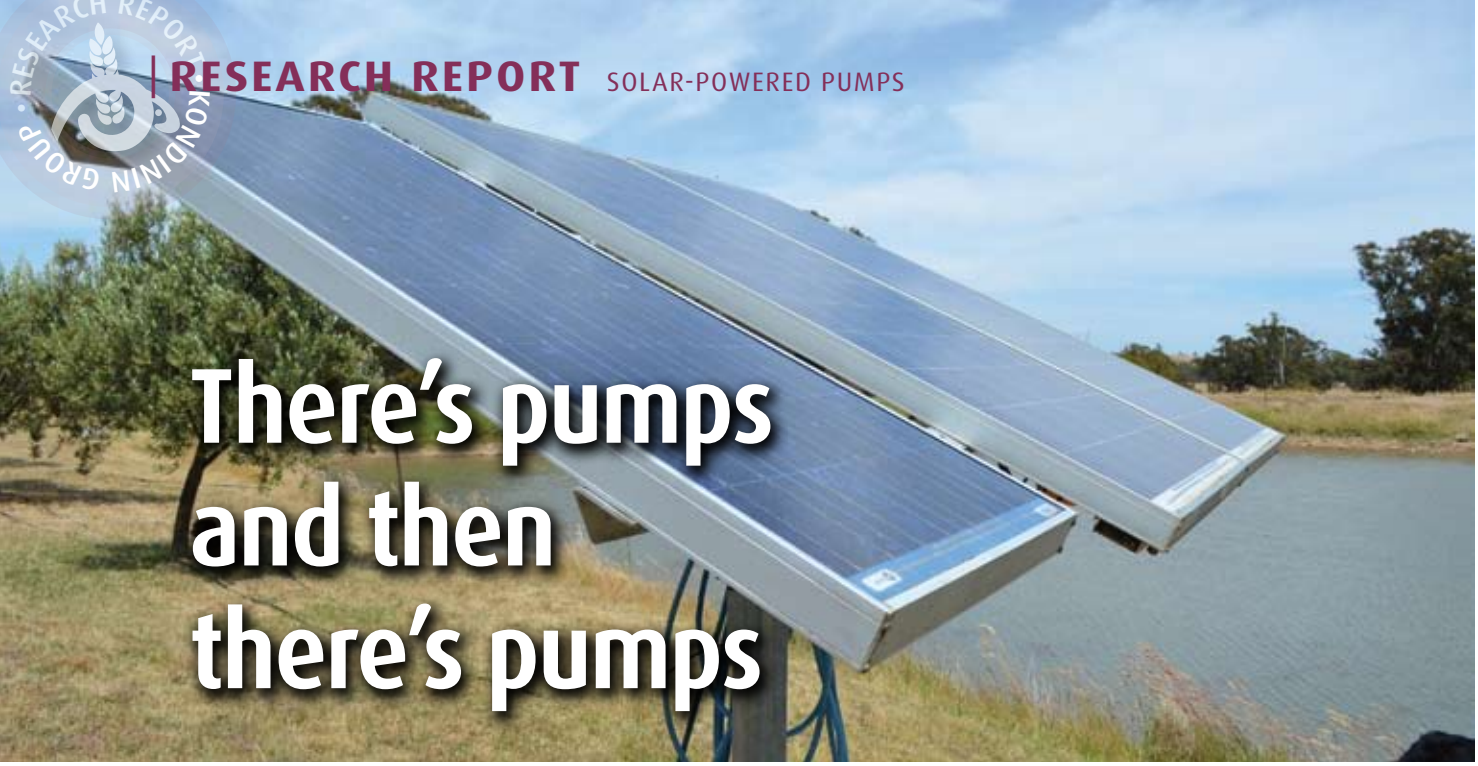

There's pumps and then there's pumps

Here's a quick wrap of the most common types of pumps and motors used for solar power applications

Diaphragm pumps

The theory behind the diaphragm pump is similar to a piston pump. However, instead of a piston, there is a flexible diaphragm.

The diaphragm means fewer wearing parts than a piston and they can typically handle higher levels of suspended solids in solution.

On the downside, diaphragm pumps contain valves which require replacement over time and the diaphragm itself will need to be replaced at some point.

Diaphragm pumps are often used to supply low-flow, medium pressure water in submersible applications and are cheaper than helical rotor pumps.

They provide positive displacement but several of the pump suppliers contacted by Kondinin Group for this report stated diaphragm pumps are far less popular for solar pumping now than five or 10 years ago.

Centrifugal pumps

In terms of simplicity of design, it is hard to go past a centrifugal pump, which is basically an impeller inside a casing.

The no-fuss design makes the centrifugal pump a popular choice especially for submersible bore applications as the impellers can be "stacked" to boost the output pressure.

Centrifugal pumps are not positive displacement pumps and are suited to high flow rates and lower output pressures.

The pumps function by imparting centrifugal force on the water, which is drawn into the centre of the impeller.

The water is rotated by the impeller's vanes and accelerated radially outward towards the pump casing and the output pipe.

Centrifugal pumps are available in radial and axial flow designs.

Radial flow pumps draw water in the direction of the pump shaft and expel it at right angles to the shaft, while axial flow pumps draw water along the pump axis but expel it in the same direction.

Centrifugal pumps are usually cheaper than positive displacement pumps and can provide high flow rates where the pressure and flow rate can be varied.

Helical rotor pumps

A helical rotor pump, or progressive cavity pump, is well suited to low flow rate, high pressure applications such as in deep wells or pumping against a large head pressure.

The pumps are simple in design, consisting of a helical, single helix-shaped shaft which rotates in a rubber outer housing. The housing is also known as the stator.

As the shaft rotates, cavities are formed between the rotor and the stator and this "draws" pockets of water from the inlet. The water is transferred along the pump housing to the outlet.

The helical rotor pump is a positive displacement pump, features a high mechanical efficiency and can operate at a range of speeds and pressures.

This type of pump is popular for use in deep wells where it can be driven by submersed electric motors but it can also be used for surface-mounted applications.

The pump can also be driven by a long, vertical shaft where the pump is connected to the shaft and placed down the well.

Piston pumps

Bore or surface-mounted systems often use piston pumps driven by an electric or internal combustion motor.

These pumps have the same basic design principle of water being moved by the piston in a positive displacement set up.

Windmill or cylinder pumps are drawn up and down by the pump rod from the action of the windmill head. The reciprocating motion lifts water from the well to the surface on the upward stroke of the pump rod.

Valves and buckets inside the cylinder pump require periodic maintenance and hence the entire pump rod and cylinder head need to be removed.

Typically there is a gear reduction drive and water is pumped on both the forward and return strokes of the piston. They are usually slow running and flow rates can be limited.

These types of pumps are far less popular today thanks to more efficient types of pumps such as the helical rotor.

Brushless DC motors

Brushless direct current (DC) motors are ideal for submersed well pumping as there are no brushes or electrical contact to the rotating parts of the pump.

The rotor contains permanent magnets and the field coils or stator are energised by the system's controller. This varies the frequency and polarity of the DC current, creating a rotating magnetic field in the stator which in turn, rotates the rotor.

The pump speed can be altered by adjusting the frequency of the current depending on the load or power that's available from the solar arrays.

These types of pumps are maintenance free and energy efficient.

Brushed DC motors

Brushed DC motors use small carbon "brushes" to provide electrical contact to what's known as a commutator on the rotor.

As the rotor turns, segments of the commutator come into contact with the brushes and this action changes the polarity of the current in the rotor.

The changing magnetic field is repelled by the stator and the resultant action drives the motor.

While generally cheaper than a brushless motor, the commutator area of a brushed motor needs to be kept moisture free. This is achieved by seals but if they fail, the pump will need to be removed from the well.

The brushes also wear over time and will need to be replaced which means the pump needs to come out of the well.

240-volt AC motors

Inexpensive, 240-volt alternating current (AC) motors require an inverter to convert the low voltage DC supplied by the solar arrays to a 240V current.

AC induction motors requires a high starting current and an even voltage supply and were far more popular with earlier solar pumping systems when DC-driven pumps were not readily available.

AC motors are not recommended for solar pumping systems due to their inefficient conversion of solar array current to 240V.

Tips

Ensure the above ground part of the system is fenced off to prevent damage from stock. If wiring and electrical components are exposed, protect them from weather and vermin.

Make sure any pipe used to carry water under pressure is fit for the job and meets requirements and standards. The same goes for fittings.

If pumping from a well or bore, make sure the bottom of the water supply is appropriately screened to prevent obstructions, silt and the like causing any problems.

Maximum pump capacity generally coincides with peak demand in hot and dry conditions.

Solar arrays can be fixed to a frame or fitted to a tracking device. Being able to track the sun's path can lead to substantial incretases in power generation over a longer period, for example six hours operation for fixed and nine hours operation for tracked in summer.

Use water tanks as a back up supply if watering is needed during the night as batteries need to be replaced.

If you are installing the system yourself, make sure you know the process. Most modern systems are "plug and play" but some may require wiring.

A strong frame is paramount for the solar arrays. The arrays cover a large surface area and hence can catch the wind.

Work out your water requirements in terms of volume and head before you start looking for a system. Also check the water quality at the source. This should include friction losses for the type of pipe and fittings used and the vertical lift from the water source to the top of the tank (or delivery system).

Some components of the system may be susceptible to electrolysis, depending on the water quality and chemical content so use similar products where possible or at least ask the supplier about the chances of corrosion and electrolysis.

Even though most solar-powered systems are low maintenance or maintenance-free, check them regularly or have a tank site indicator installed so you know how much water is available at any given time.

Set up costs can be substantial and it may be worth investigating insurance as there have been instances where the above ground components have been stolen or vandalised.

Acknowledgements

- Roger and Beth White, NSW
- WA Solar Supplies
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- YellowDot Energy

Smooth running: *Roger and Beth White said their solar-powered pumping has been running smoothly for seven years.*

Photos: Beth White

Well watered: *The Whites solar-powered pump feeds a 45,000L tank from a bore which in turn supplies stock troughs.*

They have seen the light

Beth and Roger White are solar-powered pumping converts

Based at Ben Lomond in NSW, they first installed a solar-powered pump seven years ago for stock watering and Roger said it was the best thing he ever did.

"It's a great system for supplying stock water, smooth running and it requires little maintenance," Roger said.

"There's no mucking around with pumps. With low water level and tankfull cut off switches in place it's very easy and looks after itself. It's set and forget really."

The Whites installed two sets of solar panels and pumps which feed 45,000L poly tanks from a bore. The tanks then supply concrete troughs for stock watering.

The total head requirement of the system was 65m and the Whites chose German-made solar equipment, not wanting to skimp on quality. The pumps were helical rotor design.

"Initially it was quite expensive to buy," Roger said.

"But it's been running smoothly and the system is virtually maintenance free."

Including the purchase of the tanks, solar arrays, pumps, plumbing equipment, controllers and fencing to protect the arrays and pumps from stock damage, the Whites have spent about $20,000 on the system.

Roger said the only drama was when one of the control boxes failed but that was due to a lightning strike.

"It's coped with hail so far but I'd recommend getting the gear insured as it can be damaged by forces out of your control."

Another key factor to keeping the system going is protection of the bore head and solar arrays from stock.

Roger and Beth installed RHS posts in concrete to form four corners around the arrays and bore head to ensure cattle did not wreck any of the equipment.

He said it was also important to protect from frost and then practice vermin control to help protect wiring and sensitive electrical equipment either by covering components or placing them in a protective box.

"We have placed a few camphor blocks around the bore head to keep the rats and mice away and the fencing has worked a treat to keep the stock out."

As the system is designed to ensure stock have water, Roger said he still prefers to check the equipment every week.

"We have site level indicators on the poly tanks but for peace of mind I still like to make sure the gear is OK. But that's where having a large storage tank comes into play.

"Once you've worked out your stock requirements, you should make sure there is enough storage for a few days' water supply as a reserve, just in case."

Roger has just installed another solar-powered pump but this time he chose a Chinese-made pump, which is about half the price of the equivalent German gear.

"The Chinese-made, helical rotor pump has been working fine so far, but we will just have to wait and see over time if it proves as good as the European equipment.

"It certainly looks the goods so far. We just provided the supplier with the depth of the water, distance to the tank and the height it was to be lifted and it was delivered. All the wiring was measured and fitted, ready to plug-in gear, so that made it really easy to install."

Roger said if you are planning to use a similar system, do not skimp on the quality of the poly pipe or fittings.

"It has to be the right grade of poly pipe, able to handle the pressures expected.

"And don't forget the fill point for your storage tank should be at the top and that's where you measure your head requirements from. So the vertical lift is from the bore depth to the top of the water storage." **FA**

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Powerful solution for olive growers

Converted: *Kevin and Deb Whithear are solar power converts. They have an off-grid system which is self-contained, but with a diesel generator back up.*

Kevin and Deborah Whithear knew solar power was the way to go when they built a house and planted an olive grove on a property at Avenel in central Victoria

There was no mains power supply to the property so Kevin and Deborah decided to go solar right from the word go.

Back then, a 50 per cent government rebate was in place for the cost of the system, which provided an added incentive but Kevin said the move to solar was something he and Deb had contemplated for a while.

"We did a bit of research and had an inkling that power prices would only be going one way," Kevin said.

"Plus the cost to get the mains power to the house a distance of about 1.5km was going to be substantial so we decided solar was the way."

Today, the Whithears have a completely "off-grid" power system which means there is no access to mains power.

Their solar-powered system was installed by Harmonic Energy in Melbourne.

A set of solar arrays sit atop a large shed where the Whithears process their olives for oil and four years ago a smaller array was installed next to a dam near the house.

The smaller array runs a submersible pump which pumps water from a dam up a vertical lift of 90m to supply water to the house and surrounding gardens via a header tank.

One of the main features of the system according to Kevin is its low maintenance.

"It was easy to install especially as the wiring is just a matter of joining plugs."

The Whithears have a large diesel generator as a back up as well as a substantial bank of batteries for the power supply to their olive handling machinery.

Kevin does not like to run his battery backup below 60 per cent because of the impact it has on its longevity.

On the few occasions he has reached that target he has opted to turn to his diesel generator to help with domestic power supply.

"When we are in full swing processing olives, we need the generator running but for most of the time, the solar takes care of everything else." **FA**

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