Solar technology applied in an ingenious way

A solar power system was considered the logical way in which to provide electricity to power the irrigation pumps on a new macadamia farm on the outskirts of Hazyview, Mpumalanga. An innovative solution has been devised to utilise the various advantages of solar energy and to reduce the risk of cable and solar panel theft.

The approximately 315 solar panels are fixed just above the water level onto specially treated wooden poles planted in a dam on aluminium rust-free frameworks, making it difficult to steal cables or panels.

Image Source: AgriOrbit

Francois Badenhorst who developed the 140ha Perry's Bridge farm for Jack Brotherton, a businessman well-known in the aircraft and tourism industry, is himself a farmer in the area. The fact that the solar panels are not erected on valuable farmland where trees will be planted, makes the system even more appealing.

Control over power delivery

The system only provides power when the sun shines, and batteries are therefore necessary if power storage is required. Solar panels are, however, more cost-effective over the long run than if Eskom would be used. With this system, the producer has full control of power delivery, while with utility power he would be subject to load shedding and power outages that could result in great damage if these occur at critical times.

From 40 to 50% of a farmer's utility bill is allocated to fixed costs, which he has no control over. He has to pay this regardless of how much electricity he consumes. According to calculations, the capital cost of a solar system can be paid off in seven years with money he would have spent on Eskom power to cover the same workload.

The system for this farm was provided by Telenetix Solar in Centurion. Mias Nieuwoudt, CEO of the company, confirms that solar power is indeed more cost-effective and says once the capital cost of the system has been settled, the power generated costs virtually nothing.

Benefits of solar panels

The panels are guaranteed for 25 years and are also not easily damaged by hail. He adds that since 2016, a government tax benefit has been granted to encourage the use of solar energy. According to this concession, 100% of the cost of the system can be retrieved within the first year, representing approximately 28% of the purchase price. This improves the return on investment (ROI) in a solar system by up to 38%.

The latest technology is used in the system at Perry's Bridge. The direct current (DC) electricity generated by the solar panels is converted through an alternating speed drive to single or three-phase alternating current (AC). No power is required from the Eskom network and the irrigation pumps are powered fully by solar.

An additional benefit of the system is that it can be used for power supply in remote areas far from the existing Eskom power grid, without the high costs involved in the construction of a power line. The system can be expanded systematically if more power is needed, simply by adding more modules. Moreover, it is a low-voltage system, which means the farmer himself can handle the maintenance and upkeep.

Setting up the system

The cost to install the system amounts to between R12,000 and R15,000/kW – all of which can be written off against tax. If necessary, a battery system can be connected for power storage, but this is expensive and the technology is not yet cost-efficient. Nieuwoudt says the technology is now rapidly being improved and he believes that within two years he will be able to recommend it with confidence.

Badenhorst says the farm consists of old tobacco fields, on which citrus and mango trees were planted later. It is a very humid environment, and fungal diseases have made it challenging to farm with these crops, but the climate is highly suitable for the cultivation of macadamia nuts. Macadamias require relatively little labour. Hail and wind do not cause significant damage. Stink bugs, which represents the main challenge, can be managed relatively well.

Another source of water was used in the past to the cultivate crops, but with the new development, it was necessary to build a soil reservoir which holds about nine million litres of water. Thereafter it was decided to install the panels above the water to reduce the risk of theft. The panels are fixed to the frame with special fasteners, and a special tool is required to loosen the fasteners if the panels have to be removed. The fasteners could, however, be broken by force, but since they are above water that is too deep to stand in, this option is virtually impossible.

Securing the system

After the soil reservoir was constructed, wooden poles – specially treated to withstand water – were planted at the bottom. Waterproofing at the bottom was done in such a way that the poles would fit through holes in the waterproofing. Three rows of poles were planted for every rust-free aluminium frame. The panels are fixed to the frame and the wiring is inserted before water is pumped into the dam, Badenhorst explains.

The total electricity generated comes to 30kW per pump. Imported A-grade panels were used and were mounted on the frame diagonally to optimally harness the sun's rays. The 315 panels erected are sufficient for the first three phases of the development. Another 105 panels will be installed later to serve the last phase.

In the pump room, three pumps were installed, each pumping water through a purifier first and then through a drip irrigation pipe that can service 60ha. Initially, only one dripper pipe has been laid next to the young trees, which were planted on ridges so that water could be applied from three drippers close to the stem. As the trees grow taller, a second dripper pipe is laid on the ridge about 18 months later and a third dripper pipe another 12 months down the line. This is done so that each tree is eventually served by nine drippers that irrigate the entire root zone.

Water supply

The ridges on which the saplings are planted are 800mm high and 2m wide, and in the rows saplings are planted 3m apart. The rows are 7m apart and there are 45 trees per hectare. The entire system is also served by storage of 9,600Wh.

The pumps and irrigation system runs only when the sun shines. The application of water is controlled by a computer system to ensure that the trees get the correct quantity needed. Moisture meters determine the moisture content of the soil and sends the information into the computer programme. The computer switches the system on at about 8am, when the panels produce enough power to operate the pumps. Depending on the moisture content of the soil, water is administered for two to eight hours. The computer automatically turns the system off when the orchard is sufficiently irrigated.

Badenhorst says the idea is to apply the water slowly and continuously so that the tree can use all the water and nothing is wasted. As the water slowly penetrates the soil, it tends to seep to the sides rather than penetrating downward. The system is capable of applying 63 litres of water per tree per day. It has been found that it is not necessary to irrigate for more than eight hours.

Applying fertiliser

Fertiliser is applied on the basis of a soil and leaf analysis. Concentrated fertiliser is dissolved in water inside two tanks in the pump room, where it is led to a dilution tank, further diluted and then fed into the water pipe between the pump and filters.

To prevent clogging, clean water is pumped through the pipes at the end of the process. To avoid the formation of open spots of soil on the ridges, weeds and grass are allowed to grow there – but are kept short in the furrow. The cuttings are used as mulch placed around the saplings, the aim being to minimise evaporation, protect soil life and prevent wind damage to the small trees.

Badenhorst says the main aim is to only irrigate the trees if the sun shines. If the sun, however, does not shine, the trees use almost no water. The irrigation system, therefore, fits in well with the crop system. It is a low-pressure irrigation system administering the water slowly and evenly, making it possible to keep the moisture content of the root zone on veld capacity. As the tree uses water, water levels are merely topped up, thus avoiding over-irrigation and preventing oxygen from being driven out of the soil, which can cause roots to die.

If the water becomes cloudy and the system fails to generate enough electricity to propel the pumps, the trees can survive three to five days with the available moisture in the soil. Usually, however, it rains if it becomes cloudy and the evaporation rate is also lower. If it does not rain while cloudy conditions occur, trees should be given extra water once the pumps are running again – to get the soil in the root zone on veld capacity once again.

Badenhorst says the system is brand new and it is too soon to predict what additional benefits can be expected. Producers making use of similar systems, say their experience is that they can harvest their macadamias at an earlier stage than normal and that the yield is higher. - *Andries Gouws, Farmbiz*

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