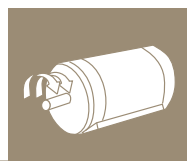


# Variable Speed Drives: Reducing the energy cost of irrigation on farms



## Lower your farm's irrigation costs with Variable Speed Drives (VSDs)



**T**he electric motors that drive pumps on irrigation systems are extremely energy-intensive, making irrigation systems one of the largest consumers of electricity on South African farms.

Variable Speed Drives (VSDs) can reduce energy consumption at the pumping plant by regulating electric motor speeds to match the energy demand with the system load – whilst balancing voltage. In doing this, VSDs reduce irrigation systems' energy consumption and contribute to lowering your farm's operating costs.

**Think of a VSD** as a "design compensator" that closes the gap between the design specifications of your irrigation system and the system's energy demand to achieve optimal efficiency.

### What is a VSD?

**A VSD** – also known as a Variable Frequency Drive or Adjustable Speed Drive, is a device that can adjust electricity supply and regulates and adapts motor speed to match the actual demand required by the system or application it is driving, resulting in a reduction in energy consumption.

**VSDs** offer a high degree of motor control, accurately varying motor speed according to demand while adjusting torque accordingly – all within the specifications of a particular manufacturer.

**VSDs** come in many different sizes and are typically encased in boxes that can be as small as a milk carton or as big as a cupboard. Sizes range from 0.18kW through to several MW. They are available as stand-alone devices connected to the electricity supply of the motor. On some smaller motor designs – usually under 15kW – VSDs may be built onto motors and are available as integrated motor drives.

**A basic VSD** can be used for simple applications – such as to control a pump or a fan – where variable loads are required. It can also be interfaced with a transducer, such as a pressure or flow rate sensor, and programmed to maintain a particular setting. More advanced VSDs can be used for precise speed and torque control in complex applications like materials forming and can be interfaced with a computing system to provide real time operating data on the status and performance of a motor.

Variable Speed Drives adjust the speed of electric motors to match the actual demand of the application, thereby reducing motor energy consumption typically by 20 to 50%.



# How can VSDs optimise your irrigation system?



Motors on irrigation systems often use more electricity than needed because the system design rarely requires the motor to operate at its maximum capacity which the motor will do when not controlled. This means that they run at full speed regardless of the actual output required, wasting electricity.

Installing a VSD will regulate the speed and rotational force – or torque output – of the motor to match actual demand so that it doesn't work faster than it needs to.

Centrifugal pumps on irrigation systems are variable torque applications, which offer the highest potential to save power. Reducing the speed of the pump by a small amount will result in a massive reduction in the amount of energy used because pumps are governed by the Affinity Law of Power  $\propto (\text{Speed})^3$ . Slowing down a pump from 100 to 80% can reduce a motor's energy use by up to 50%.

In the case of an irrigation system where various sizes of land are irrigated using the same pump, a VSD can be used to adapt the speed according to the respective water and pressure requirements of the various sizes of land, instead of having the motor running at full speed and all the excess energy being dissipated by the pump's pressure regulator or throttle valve.

**A VSD** can help you to better control the energy demand of your irrigation system, while efficiently controlling irrigation requirements.

## Your irrigation system could unnecessarily be wasting electricity and pushing up your energy costs if:

- The motor runs at full speed against partially closed valves when irrigating a number of fields at different times with the same pump
- The motor runs at full speed when irrigating different sizes of fields with the same pump at different heads
- You irrigate a number of fields at different times with all the pumps running at full speed regardless of the necessary flow rates
- You are changing production volumes, or restricting the flow of the output, by mechanical means, such as valves or chokes.
- The motor continuously runs at full speed supplying water to a centre-pivot installed on a slope.

**A VSD** improves the power factor correction and has a soft starting function. When a VSD is not feasible, soft starters or power factor correction can be considered instead.

## Saving scenarios

**A VSD** can optimise your irrigation system when one pump delivers water to more than one centre-pivot, if:

- The pump is designed to deliver water to all pivots at the same time and has to be throttled when irrigation is needed for fewer centre-pivots







- The pump and motor are over-designed and water delivery needs to be throttled
- An oversized, second-hand pump and motor are used for the application and water delivery needs to be throttled
- The sizes of the centre-pivots are different
- The distance between the pumping station and various centre points varies
- The static height of the highest point of irrigated land and the respective pivots is not the same
- Pipelines between the pump and the respective centre-pivots have different friction losses
- The pressure requirements of the respective centre-pivots are different, depending on the type of sprayer package installed
- The centre-pivots are irrigating sloped topographies.

**A VSD** can optimise your irrigation system when one pump delivers to only one dedicated centre-pivot, if:

- The centre-pivot irrigates a sloped topography
- The pump and motor are oversized and water delivery needs to be throttled
- An oversized, second-hand pump and motor are used for the application and water delivery needs to be throttled.
- The centre-pivot is used to irrigate different crops with different irrigation rates

**A VSD** can optimise your irrigation system when movable pipe systems and micro- and drip-irrigation are used, if:

- The distance between the blocks of land and pump stations are different, causing a variation in friction loss and power requirements
- Irrigation blocks are uneven in size and different number of sprayers or drippers are required
- Irrigation blocks are on sloped topographies, requiring different pressure and power
- Pumps and motors are designed to deliver water to the irrigation block that requires the most pressure
- The pump and motor are oversized and water delivery needs to be throttled
- A second-hand pump and motor are used for the application and water delivery needs to be throttled.



### Additional benefits of VSDs:

- Protecting faults in electric motors and cables, thereby increasing the life span of complete systems
- Balancing and regulating voltage to electric motors
- Smooth soft starting, thereby reducing starting current and maintenance
- Automatic restarting after power outages
- Riding through power dips
- Reducing mechanical stresses and damages
- Correcting power factors (some makes of VSDs)
- Communicating with moisture gauges
- Built-in recording of energy consumption and energy saved (some makes of VSDs)
- Emergency set points and trips to protect equipment and motors
- Automatic speed control
- Precise process control
- No more broken tyre type couplings on pumps due to high starting torques
- Improved management of systems' electricity use outside peak hours
- Easy integration with SCADA or existing Programmable Logic Controller (PLC) systems
- Versatile and adaptable
- Simple to install, configure and use.

**VSDs deliver accurate control and less mechanical wear, thereby reducing maintenance and extending the life expectancy of entire systems.**

### Are there any special considerations?

- Conduct a proper feasibility study before investing in a VSD to ensure that it is the most appropriate solution towards optimising your irrigation system.
- VSDs can increase harmonics in the electricity supply, which disturb the sine curve of the Alternating Current and cause motors to run warmer than they are designed for, reducing their life expectancy. Harmonics can also decrease the life expectancy of computers and negatively influence the operation and accuracy of electronic measuring devices. The appropriate harmonic filters and chokes must, therefore, be installed along with the VSD to filter out the harmonics and protect your equipment.
- Spend a bit more on quality – VSDs are high tech; mixing low quality with high tech is not recommended.
- Full energy-saving gains will be achieved when harmonic filter protections and components are properly installed and tested.
- Since VSDs are dust sensitive, an appropriate dust filter needs to be installed when operating in dusty conditions – they also need to operate within specified temperature and humidity parameters.
- VSDs must be installed by qualified installers who can back up their product.
- Once installed, the VSD must be correctly programmed as setting incorrect parameters will result in poor control and energy wastage.
- Regular maintenance on VSDs – and associated motors – is essential to maintain energy savings; preventive maintenance is always less expensive than correcting faults and having unanticipated breakdowns.
- Opt for a maintenance contract with your supplier to ensure the VSD is kept in optimal condition.

**Important note:** If you have a power factor correction capacitor installed, remove it before installing a VSD.

In some instances it is not feasible to use a VSD because the variables are not large enough to bring about sufficient savings to justify the capital outlay. In those cases, however, it is often better to install a soft starter or change the pump impeller.

### Testimonial

An Eskom Energy Advisor conducted an energy use assessment on the farm of Kosie and his son Manie Eloff outside Soekmekaar in Limpopo Province; it showed that irrigation accounts for 61% of their electricity bill.

The Eloffs have 14 pumps of varying sizes, some of which could save electricity by using Variable Speed Drives (VSDs). Even though it is costly and a new technology in the eyes of many farmers, Kosie and Manie Eloff decided to go ahead and invest in a VSD.

They conducted a system analysis in consultation with a local supplier to determine which pumps would benefit most from VSDs and, together with the supplier, installed the VSD and made sure it was set to run their irrigation system in line with their requirements.

- The VSD was installed on a 45kW (kilowatt) motor and they replaced the throttles used to change the flow and pressure as the irrigation load changes .

By installing the VSD on the irrigation system - which was used as a pilot on the farm - energy demand was reduced from 18,9kW to 13,2kW, a saving of almost 30%. Due to this improvement in energy efficiency, Kosie and Manie Eloff are now investigating the savings potential of the other 13 pumps on the farm as well.

Industry norms indicate that the installed cost of quality VSDs should be approximately R1,200 to R1,500 per kW.

### Eskom's Energy Advisors are on standby to assist you.

**Eskom's national Advisory Service offers information on manufacturers and suppliers of VSDs. The team can also advise businesses on:**

- Reducing energy usage
- Doing walk-through energy assessments to identify energy usage patterns, energy needs, areas of energy wastage and energy-saving opportunities
- Improving the energy efficiency of operations and electrical systems and processes
- Prioritising maintenance as an important contributor to reducing energy usage; and
- Finding SANAS approved energy savings Measurement & Verification Authorities.

**Advisors can also provide information on funding opportunities for energy efficiency projects.**

**Call 08600 37566, leave your name and number and an Eskom Energy Advisor will contact you. Alternatively, ask for a specific advisor to contact you.**

**Visit [www.eskom.co.za/idm](http://www.eskom.co.za/idm) for more information.**

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[www.carbontrust.com](http://www.carbontrust.com)

Fanie Steyn, technical paper - Energy savings on motor-driven systems (Johannesburg, South Africa, 2012)

Kosie and Manie Eloff, Soekmekaar, Limpopo Province, South Africa