

Voltage optimisation units

Voltage optimisation can achieve energy savings of between five and 20 percent in situations where mains voltage is higher than is needed by farm equipment. In addition to enabling energy savings, voltage optimisation units protect electrical devices from variation – surges or drops – in mains voltage. Purchasing considerations include the type of unit and the presence of electronic devices in the circuit. The installed cost of a VO unit typically ranges between \$150/kVA and \$300/kVA.



Benefits of voltage optimisation

Voltage optimisation units are essentially transformers used to deliver power at a reduced voltage from the raw mains supply.

They are installed between the mains and the facility to save energy and to protect equipment.

Protection

Due to their locations in remote areas, farms can be affected by power supply issues such as voltage variations – surges or drops – which can damage on-farm electrical equipment. Voltage optimisation (VO) units can be used as protection devices, as they regulate the input voltage and supply the most appropriate operating voltage for the equipment.

Energy savings

Electricity utilities charge for voltage received, not voltage used. Voltage optimisation is beneficial when the electricity supply to your site is at a higher voltage level than needed.

In most regions in Australia, the nominal supply voltage is 400 V three-phase or 230 V +/- 5 percent single-phase, meaning that supply voltage can be delivered to 219 V and still meet regulations. The majority of electrical equipment is designed to operate at these voltages; however, in many cases, the supply voltage to site is higher than 240 V.

Depending on the load mix, energy savings can typically range between five and 20 percent.

Passive versus active devices

Voltage optimisation devices are available in two forms.

- In passive VO units, the load-side voltage moves up and down in line with the input voltage.
- In active VO units, the load-side voltage is maintained at a constant value within given limits, irrespective of the input voltage.

Active VO units, therefore, have the benefit of protecting equipment but will be 30 to 40 percent more expensive than passive units.

A voltage optimisation unit can be installed in series, with the mains electricity supply to provide a reduced-supply voltage for the site's equipment. This solution is generally applicable when supply voltage is greater than 390 V (three-phase). Typically, voltage optimisation can improve power quality by

balancing phase voltages and filtering harmonics and transients from the supply.

Changing tap settings

Voltage reduction can be also achieved at minimal cost by changing the manual tap setting on the transformer.

A VO device allows such reduction to be achieved more accurately, because it has more tapings, enabling it to provide finer ranges of voltage output.

Electronic devices reduce the benefits of VO

Voltage reduction is generally not suitable for use on circuits with a large number of electronic devices. The presence of electronic equipment in a circuit will compensate for the voltage reduction and reduce savings.

This type of electronic equipment may include electronic ballasts or variable speed drives (VSDs). Levels of illumination will also be lower when voltage reduction devices are used. It is therefore important to ensure that light output remains compliant with AS/NZS1680 standards. The risk of motor overheating needs to be carefully assessed as well.

Worked example

Typically, any installation will have a mix of linear and non-linear loads: fluorescent lighting, motors, compact fluorescent lamps, electric welding machine, computers and the like.

The measured input three-phase voltage at one of the farm's transformers is 420 V and it has been determined that, according to various equipment specifications, voltage can be reduced to 390 V without causing damage to the equipment. A VO supplier has conducted a survey to check the types of loads connected to the transformer and has estimated the CVR factor to be 1.1. Estimate the energy savings and payback.

Percent voltage reduced (measured versus minimum nominal supply) = $(420 - 390)/420 = 7.1\%$



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Estimated savings = %V * CVR = 7.1% * 1.1 = 7.9%

The transformer rating is 500 kVA and the annual electricity consumption of the total loads connected to it is 1,000 MWh p.a. Therefore, estimated savings are 1,000 * 7.9% = 79 MWh p.a. At an average electricity rate of \$200/MWh, the cost savings are \$15,800 p.a.

The specific installed cost of the VO unit is estimated to be \$150/kVA. A 500 kVA VO unit would therefore cost \$75,000. The estimated simple payback for this project is \$75,000 / \$15,800 p.a. = 4.7 years.

Tips for evaluating quotes

A detailed voltage survey of major loads should be conducted to make sure that no loads will be adversely affected by voltage reduction.

Voltage levels may vary from time to time and this reduces the need for voltage optimisation. A full evaluation of your voltage levels across a year may be required. This may be available from your network provider or meter data agent.

The electrical loads on your site may vary considerably and this may mean that higher-cost active VO units are required.

The installed cost of a VO unit typically ranges between \$150 and \$300 per kVA.

The conservation voltage reduction (CVR) factor determines how effective VO is in reducing energy consumption for a particular installation or load make-up. The higher the CVR factor, the greater the savings. It is calculated as: CVR factor = %E (percentage energy reduced) divided by V (percentage voltage reduced).

The CVR factor varies significantly depending on the type of connected load and studies have shown that it can range from 0.2 to 1.5. Usually, it is recommended that an electrical survey be conducted at your installation beforehand so an estimate of its CVR factor can be made.

Further information

Energy Management Systems UK

Information on voltage optimisation.

voltageoptimisation.info/questionsanswered.html

Victorian Department of State Development, Business and Innovation

Information on energy, resourcing and voltage optimisation.

www.energyandresources.vic.gov.au/energy/about/legislation-and-regulation/energy-saver-incentive-scheme-management/scheme-expansion/review-of-activity-submissions-for-the-energy-saver-incentive-2012/power-controllers

References

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