Nidec Drives

Irrigation in Agriculture

Contents

Next-level irrigation

Harnessing control technologies to boost profitability, efficiency and sustainability

Solar-powered irrigation systems (SPISs) are emerging as a beacon of sustainability in the agricultural sector, reducing emissions while offering stability, resilience, increased production and yield.

At the heart of these innovations lie advanced control technologies, transforming equipment from mere operational tools to catalysts for colossal energy savings and smarter operations.

The path to maximising the benefits of solar-powered irrigation involves not just adding any control system but choosing solutions aligned with the needs of agriculture's digital future.

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Introduction

With rainfall being inherently unpredictable and often insufficient to maximise crop production, irrigation is practiced on a global scale to support the farming and food sectors. For example, it is estimated that, without irrigation, the global production of cereals would decrease by 47%[1],heavily impacting farming and food production activities.

With over 320 million hectares of land currently equipped for irrigation, representing over 20% of all arable land[2], it is estimated that a staggering 62 TWh of energy is used every year to operate the pumps responsible for global agricultural irrigation[3]. Aligning with international decarbonisation efforts, the shift from conventional fossil fuels to renewable energy sources within irrigation activities can therefore have a considerable positive impact, slashing greenhouse gas (GHG) emissions.

Among the most promising solutions for agricultural businesses are solar-powered irrigation systems (SPISs), which leverage photovoltaic panels to generate electricity, which is then used to operate pumps for the abstraction, lifting and/or distribution of irrigation water. Such a setup can greatly contribute to making these operations almost carbon neutral.

In effect, current cradle-to-grave lifecycle assessments (LCAs) indicate a potential reduction in GHG emissions per unit of energy used of 95-97% when compared to pumps operated with global average energy mix from the grid, and 97-98% compared to diesel-based alternatives[4]. Taking into account that in the United States alone, 26% of agricultural pumps run on fossil fuels[5], the potential reduction of carbon emissions can be significant.

Besides reducing the environmental impact of water pumping, SPISs can also help agricultural businesses enhance their resilience and overall capabilities. For instance, they can support irrigation in remote areas that are not connected to the grid and support the electrification of rural communities. These solar-powered solutions can also drive more efficient resource utilisation, ensuring effective operations during dry spells while preventing unnecessary watering during rainy periods.

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These advantages do not solely benefit fields in hot or arid countries, but worldwide. In particular, when low pressure drip irrigation is used in combination with solar pumps, its proper operation can increase both water and fertiliser efficiency in the irrigated system. Ultimately, SPIS users can stabilise, increase and/or diversify production, enhancing the sustainability, productivity and profitability of farming activities while improving food access and security.

Even more, optimum resource utilisation can deliver substantial benefits across the entire agricultural value chain, as climate change mitigation strategies become the norm. In effect, agriculture accounts for 87% of total water consumption and withdrawals, including blue and green sources, and approximately 60% of global freshwater withdrawals are used for irrigation[6].

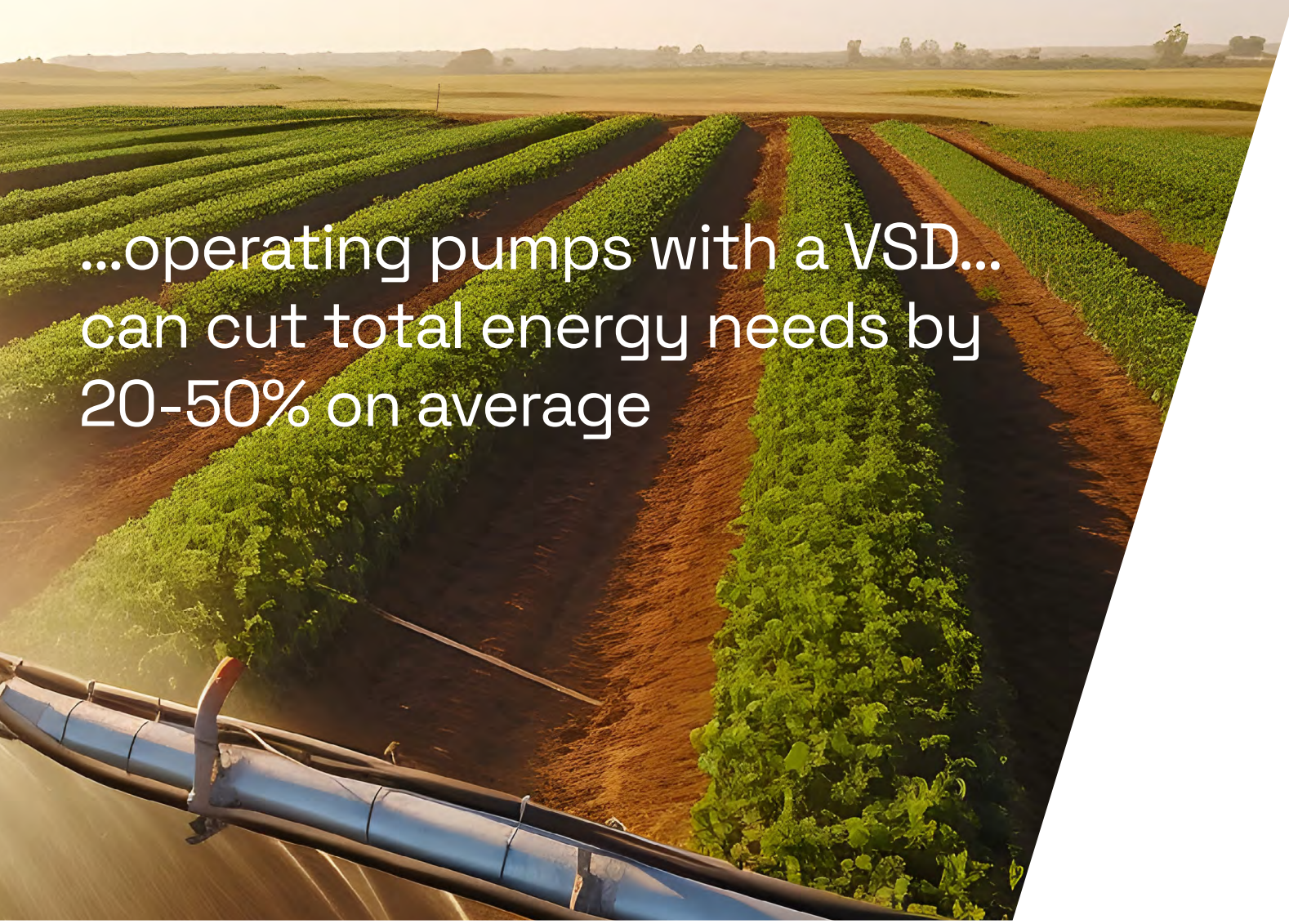
The role of SPIS Control Technologies

When looking at implementing SPISs, using a pump control system is highly beneficial. This plays a vital role in determining the energy requirements of irrigation solutions, influencing efficiency, environmental performance and operational expenses.

Historically, control solutions based on variable speed drives (VSDs) were used solely to support operations, e.g. providing constant output pressure, offering soft starts or reducing wear. However, they have emerged as a key technology to deliver considerable energy saving. In effect, by operating pumps with a VSD, it is possible to optimise energy utilisation as well as reduce energy being dissipated or bypassed. This can cut total energy needs by 20-50% on average[7] and therefore improve the management of solar power generated by SPISs.

Typically, when a single pump is used to operate over a range of flow rates and pressures, the equipment specifications are based on the greatest output demands. This leads to the implementation of oversized pumps and motors that are unable to address significant variability and, thus, run inefficiently at lower flow and pressure demands.

Conversely, VSDs enable pumps to operate efficiently across a wider speed range, which helps meet varying conditions, consequently reducing energy consumption. For these reasons, legislation such as the EU Ecodesign Directive 2009/125/EC[8], also known as the Energy Related Products (ErP) Directive, mandate the use of drives to improve energy efficiency and the environmental impact of the entire system.



...operating pumps with a VSD... can cut total energy needs by 20-50% on average

Moreover, considering that usually 85% of a pump's lifecycle costs are associated with energy consumption, the use of drives can considerably reduce the total cost of ownership of SPISs. This advantage increases the affordability and scalability of more sustainable irrigation solutions.

In addition, pressurised irrigation scenarios using single-speed pumps that necessitate variable flows often involve off-loading water to areas not requiring irrigation to keep the pumps operating at their most efficient duty point. With VSDs, pumps can automatically adapt their performance, so there is no need to divert excess water to areas not in need of irrigation. End users can therefore improve their irrigation schedules and prevent issues such as rootzone waterlogging and water wastage.

Ultimately, VSD-controlled SPISs can enhance land management, energy and resource utilisation while further reducing operational expenses.

> **...mandate the use of drives to improve energy efficiency and the environmental impact of the entire system.**

Futureproofing SPISs for smart irrigation

In addition to supporting more efficient, reliable operations and helping to extend equipment service life, control technologies can also help agricultural companies advance on their digitalisation journey and, in turn, unlock new improvement opportunities. Firstly, through VSDs and/or other controllers, such as PLCs, connected to pumps, companies can gather useful data rather than uninterpretable analogue signals.

The processing, analysis and visualisation of this digital information can help generate actionable insights, making SPISs and irrigation operations more agile and effective. For example, with SPISs that are connected to an energy optimisation platform, users can determine energy use, payback periods as well as flag potential inefficiencies.

By adding sensors to such frameworks, it is also possible to gain even more comprehensive overviews, as these can help monitor equipment conditions and support predictive maintenance, for example detecting early signs of component wear to avoid unexpected failures. Furthermore, it is possible to have greater control over energy use and to identify other value-adding improvements.

Digital solutions can deliver real time soil and weather condition information too, enabling more targeted actions, such as supporting controlled deficit irrigation. Taking into account the different response of crops to water inputs during each growth stage, these strategies can reduce water utilisation without impacting yield.

Identifying suitable VSDs for Irrigation

While the addition of VSDs to SPISs can deliver key benefits per se, the selection of solutions with application relevant features can help agricultural companies maximise the gains and overall benefits delivered by this equipment, contributing to the creation of highly effective setups. Firstly, companies should favour drives that offer key functions for water flow and irrigation applications.

It is especially important to select solutions that can automatically stop pumping operations when certain dry run situations occur, such as no or low-flow, tank full or well dry, to safeguard the entire setup. Equally, the drive should be able to restart the pump under suitable conditions while preventing spikes in pressure.

Gain greater control over energy use and help identify other value-adding improvements

The ideal VSD should also be able to ensure reliable pump operations through a flexible, redundant system for energy supply. Robustness and functions to limit in-person maintenance, e.g. through automated pump cleaning cycles, are also highly advantageous, as they minimise cost while maximising up time and service life. Besides, adopting solutions that can be easily scaled up can help companies to sustainably and confidently grow their SPIS installed base.

Advanced control functions to regulate energy use should also be specified, as these can help end users reduce their energy requirements and associated costs. When combined with an energy monitoring platform as part of a packaged offering from a full-service provider, further gains are within reach, such as streamlined investment costs and simpler implementation.

Nidec Drives' Support for SPISs

Nidec Drives' latest offering, its easy-to-install Control Techniques Solar Pump Solution, is designed to address the specific needs of SPISs by combining its advanced general-purpose drives and software for energy management. Thanks to the company's fifty years of expertise in drive design, the VSDs available within this complete package, the Commander C and Unidrive M, embed dedicated features for highly effective irrigation.

These include dry-run prevention, pipe fill, no-flow detection, tank full/well dry automatic stop functions and pump cleaning. Additionally, they are equipped with level switch control modes to handle both single and parallel pump configurations. In order to ensure continuous, reliable pump control, the VSDs offer low solar radiation start/stop and accommodate flexible power supplies. More precisely, they can automatically connect to AC sources when solar power generation is limited, such as at night.

To optimise energy usage, Nidec Drives' VSDs also come with an advanced low load power saving function, which dynamically reduces the voltage applied when demand is low to reduce losses in the motor, making the entire system more efficient. In addition, thanks to accurate proportional-integral-derivative (PID) control, when demand falls below a predefined setpoint, the drives automatically enter into a sleep mode, restarting operations when demand exceeds the threshold, reducing energy use and equipment wear.

Equipped with built-in PLCs, the Solar Pump Solution's drives minimise the control system footprint and streamline programming while delivering unique data-driven capabilities for smart applications. By communicating with Control Techniques' MPPT (Maximum Power Point Tracking) optimisation software, users can accurately monitor energy use as well as benefit from key diagnostic tools to speed up troubleshooting and problem solving, maximising uptime.

Finally, the SPIS package supports various communications protocols and technologies, making the solution extremely interoperable and easy to integrate within new or existing networks and architectures.

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Case study:
Autonomous vineyard irrigation

The family-run Txakoli Bikandi, a small winery in the valley of Durango, Basque Country, Spain, has been producing wine for more than 50 years from its 30,000 m² site. In between Mount Anboto and Mount Oiz, the Bikandi Txakolina vineyard is isolated from the grid. When in need of a solution to effectively irrigate its grape vines, the wine manufacturer was keen to introduce an economical, quick to implement solution.

Nidec Drives helped the Bikandi family develop a SPIS by providing a custom Solar Pump Solution that combined two Commander C200 VSDs with built-in PLCs and MPPT optimisation software. Thanks to these control technologies, the company can support the optimal growth of its many grape varieties, which include Ondarrabi Zuri, Riesling, Folle Blanc, Gros Manseng, Sauvignon and Chardonnay to produce approximately 60,000 litres of wine every year.

Conclusion

Irrigation is a crucial aspect of agricultural operations, and its role is only likely to grow in the future. To enable the effective management of water and plant growth while improving the environmental footprint of irrigation systems, companies should look at solutions that use more renewable resources and minimise energy consumption.

Well-designed SPISs are ideal to address these needs and help farming businesses thrive while supporting global food security and accessibility. However, solar-powered solutions require highly effective control technologies to ensure reliable, smooth water irrigation.

Nidec Drives, with its Control Techniques Solar Pump Solution offering, is a premier full-service provider that can deliver high-quality, interoperable hardware and software components that have been specifically designed for SPIS applications. By partnering with Nidec Drives and specifying its products, end users can leverage value-adding setups that optimise energy and resource utilisation while minimising costs. As a result, companies can benefit from powerful, futureproof SPISs that drive competitiveness and profitability in the agricultural industry.

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