HITACHI
Inspire the Next

Maximizing solar powered irrigation

Combining solar power with variable frequency drives improve efficiency

In practice for over 5,000 years, irrigation is now the beneficiary of continuing innovation in solar power. Solar energy has undergone a startling drop in price, with solar panel and storage battery technology advancing so rapidly that solar energy is predicted to be cheaper than fossil fuels almost everywhere on the planet by the end of this decade. Solar powered irrigation systems have the potential to change the a basic human practice in low and middle income countries, as well as high income societies.

Efficient crop irrigation is more than an engineering challenge, it is increasingly an economic challenge as the demand for water is beginning to exceed supply.

The centuries-old means of flooding the fields that is still in use today, is wasteful and inefficient. Most farmers set up some sort of sprinkler or micro-drip irrigation system requiring a pumping system to bring the water to the fields. Conventional pumps are driven by fossil fuels, whether it is a combustion engine or an electric motor.

Today, using a solar powered system to power an irrigation pump, and them installing a variable frequency drive system to control the pump provides immediate efficiency and advantages:

- **Greatly reduced operating costs**
- **Elimination of emissions from burning fossil-fuels**
- **Higher return on investment**

The biggest barrier to setting up solar powered irrigation is the initial cost; but, the benefits are enormous. Costs for solar panels have dropped and the average life span of a solar panel is estimated at 25 years. Solar requires no fuel so operating maintenance costs are minimal.

There are other advantages as well. Farmers can use excess electrical energy that was produced for irrigation to power lighting and other services – a big plus in remote areas.

A solar power system is designed to be self-contained so farmers can use them "off-the-grid," meaning the system is not connected to conventional electricity supply. In rural and remote areas, this is an attractive detail. Areas with poor grid connectivity or that experience frequent power shutdowns due to earthquakes or hurricanes can continue to operate.

If the solar power source is connected to the grid the power generated is used as an alternate source of energy, allowing growers to work with a smaller number of solar panels or without a battery, which reduces the initial cost of setting up the system.

Combining a solar powered pump with a variable frequency drive maximizes the efficiency and convenience of a controlled irrigation system.

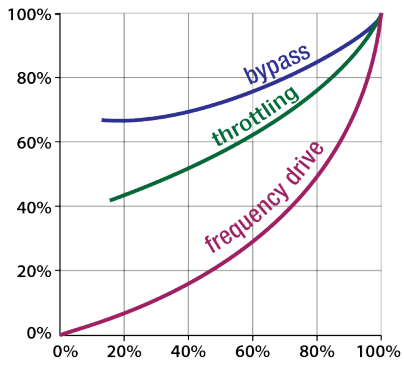
Water flow in a traditional water supply is either on or off. Commonly used methods for flow control include restrictive devices such as valves, outlet dampers, inlet vanes and diffusers. Mechanical speed changers and recirculating systems are also sometimes used. However, all these devices waste energy. Fixed-speed pumps draw nearly full horsepower and consume nearly maximum energy full time, regardless of demand. Power requirements for throttled systems drop only slightly even when flow or volume is reduced significantly.

Variable frequency drives are electric controllers that vary a pump's speed and flow, allowing it to respond smoothly and efficiently to fluctuations in demand. When properly installed, a variable frequency drive eliminates the need for throttling and restrictive devices. Combining a variable frequency drive with a solar pump allows farmers to consistently deliver controlled amounts of water to crops with an automated and simple to operate system.

For example, implementation of a variable frequency drive to control center pivot system of pump, piping, and water distribution components offers much more efficient control of irrigation flow rates. A variable frequency drive can prohibit these conditions as well:

- **Pipe damage that results from over pressure and water hammer in long pipe runs, potentially flooding fields and ruining crops**
- **Undetected loss of prime that results in continuously running pumps and premature motor burnout**
- **Undetected leaks in pump motor seals leading to pump failure**
- **Changing crop conditions that dictate flow/pressure setpoint changes**

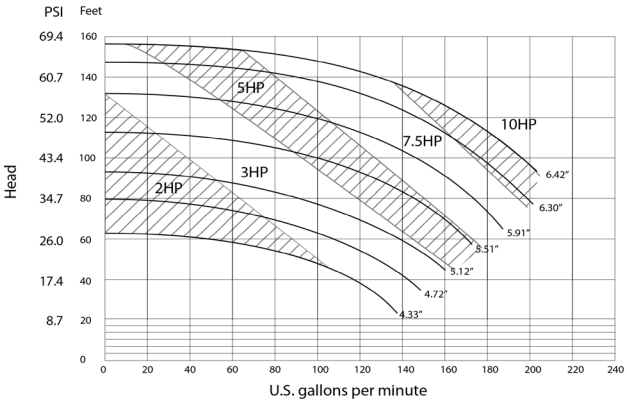
The best way to see the difference between a system with a fixed speed pump and a variable frequency drive is to compare the pump system curves of both methods. Pump engineers use a pump system curve to determine a pump system's ability to describe what flow will occur at a certain pressure.



On the system curve shown above, a single performance curve shows the pump performing at a fixed speed. Fixed speed pumps draw nearly full horsepower consuming maximum energy full time, regardless of demand. When water is turned off

Hitachi Industrial Equipment & Solutions America, LLC
Hitachi Industrial Equipment Systems Co., Ltd.
HIESA 10.21.21-SOLAR

Check out additional inverter options at
www.hitachi-iesa.com/vfd
or call 980-500-7141



using a valve, only the flow is blocked, the power is continuously on full speed. Flow is blocked and the system runs dry, until the valve is opened, and flow is provided again.

On the curve shown above on this page, there are a range of performance curves relating to the different speeds that are achieved with variable frequency drive. The difference here is that the variable frequency drive varies the pump speed to control the flow rate.

Varying the speed with a variable frequency drive has the same effect as installing a different-size impeller on the pump while requiring reduced power. It essentially displays a new pump curve.

Addressing Cost

Many variable frequency drives are built to handle a wide variety of pumping applications with capabilities beyond irrigation needs and are available at typically 20% less cost than pump specific variable frequency drive. These controllers can be controlled with specialized irrigation software that eliminates the need for additional devices. With software-delivered capabilities, farmers only pay for the control panel functions they need.

Addressing Flexibility

As irrigation requirements change over time or new capabilities like Variable Rate Irrigation are desired, a simple software update can easily incorporate new features into the control panel. No additional hardware is required in the panel and the useful life of the farmers' original investment is extended. Use of software allows increasingly sophisticated pump control without the need for extra hardware, installation and maintenance.

Addressing Simplicity

Specialty pumps with extra hardware components add complexity that can lead to operator error resulting in wasting water and energy, and even decreasing pump motor life due to overuse. Many variable frequency drive have a dizzying array of control parameters that confuse farmers, making setup and operation difficult, and irrigation results unreliable. In contrast, software built specifically for irrigation applications can continuously monitor for seal leaks, pipe breaks, loss of prime etc. — even execute a line fill cycle that eliminates water hammer. For the farmer this means virtual push-button simplicity, lower maintenance costs and consistently optimized irrigation.

Many Choices

Today's farmer has many choices, along with many questions. Achieving efficient and economic farm operation is possible. With careful research, growers can optimize many tasks, and the US government is offering financial and technical support for using solar power and variable frequency drives. For businesses and ranches the capital costs for the solar electric system are eligible for the 30% Federal Tax Credit and Accelerated Depreciation benefits. Other benefits may be available in your location. Consult your accountant and http://www.dsireusa.org/ for more information.

Common sense supports the building of modern, sustainable water supply systems to improve crop production, conserve water and maximize the investment in agriculture. Irrigation pumps, a significant and necessary part of any farm operation, are undergoing innovations that increase their usefulness. Among the features pump users should investigate are:

Pump Functionality—Features are specifically designed for pumping applications that minimize start-up time and provide a smooth interface for operators.

Application Support—Application engineering support is an essential resource for users before, during, and after the installation.

Using a solar powered pumping system and variable frequency drive provides additional savings because many elements required in a valve-controlled system are eliminated or reduced without affecting the function. Further, software controlled variable frequency drives can perform functions previously handled by programmable controllers, improving process flexibility, and further eliminating components and cost.

Selection should depend on flexibility, options, service and support critical to the business and operational success of the control system. The importance of choosing a supplier with the appropriate technical capabilities and expertise in variable frequency drive used in combination with solar powered pumps cannot be overemphasized.

The goal of building a modern, sustainable water supply system for improving crop production while conserving natural resources is possible.

Hitachi Industrial Equipment & Solutions America, LLC
Hitachi Industrial Equipment Systems Co., Ltd.
HIESA 10.21.21-SOLAR

Check out additional inverter options at
www.hitachi-iesa.com/vfd
or call 980-500-7141