LISTEN.
THINK.
SOLVE.®

Energy Savings with Variable Frequency Drives

Invest in Energy Management with Intelligent Motor Control Solutions

WAYS TO WIN IN ENERGY MANAGEMENT

Beat peak demand charges
Reduce current peaks when starting large motors with variable frequency drives (VFD) that gradually ramp the motor up to speed.

Optimize power usage in response to actual load
Manage input power based on system demand and use only the energy required by the driven equipment.

Power factor makes a difference
VFDs that are near-unity true power factor (at least .95 PF) translate to reduced energy use.

The hidden cost of transformers
Transformers are large, heavy, expensive, and contribute to energy loss.

Generate your own energy
Consider VFDs that regenerate power which can be routed back to the system or sold to utilities for additional revenue.

Use one drive for multiple motors
Synchronous transfer capability uses one VFD or softstarter to start multiple motors to reduce full load current and reduce energy consumption.

Intelligent Motor Control
Intelligent motor control today integrates advanced networking and diagnostic capabilities to better control performance and increase productivity, while reducing energy use.

Choose the right VFD
Evaluate your facility, application, and the variable frequency drives on the market that use advanced technology features such as regeneration, synchronous bypass, transformerless options, and software to optimize energy consumption.

Rising energy prices create a need for energy-efficient motor control solutions. To help reduce energy losses, process engineers are turning to variable frequency drives (or adjustable speed drives) as an alternative to fixed speed controllers and throttling devices such as dampers and valves.

Advancements in drive technology, careful selection of the hardware and power system configuration, and intelligent motor control strategies produce improved operating performance, control capability and energy savings.

Things to consider when choosing a motor control solution include peak-demand charges, operating at optimized efficiency, power factor, isolation transformer cost and losses, regeneration capabilities, synchronous transfer options and specialized intelligent motor control energy-saving features.

Optimize Power Usage
Centrifugal loads offer the greatest potential for energy savings by using variable frequency drives (VFDs) to control speed. Energy consumption in centrifugal fan and pump applications follows the affinity laws, which means that flow is proportional to speed, pressure is proportional to the square of speed, and horsepower is proportional to the cube of speed. That means if an application only needs 80 percent flow, the fan or pump will run at 80 percent of rated speed and only requires 50 percent of rated power. In other words, reducing speed by 20 percent requires only 50 percent of the power.

Energy savings can also be realized by managing input power based on system demand. Vattenfall Europe Mining AG, in Germany, modernized the overburden conveyor systems of its open pit coal mine with 6.6kV Allen-Bradley PowerFlex 7000 medium voltage VFDs. The drive's inherent regenerating capability allows fast, co-ordinated deceleration without the need of braking components and without wasting energy. The optimized conveyor loading (OCL) ensures system efficiency by using a material tracking system across an array of conveyors to continuously adjust speeds so that the conveyor belts are fully and uniformly loaded. A partly loaded conveyor wastes energy and causes unnecessary wear.

Vattenfall's biggest benefit is the reduced amount of installed drive power. Before modernization, the conveyor required six fixed-speed controllers at 1.5MW each, totaling 9 MW to start the motor. The conveyor with a variable speed solution now uses installed power of only three units at 2MW each, for a total of 6 MW to generate a smooth start.

Beat peak-demand charges

VFDs also affect peak-demand electricity prices that the utility charges to companies that exceed a preset limit, such as when industrial motors started across-the-line draw large peaks of current. VFDs help reduce the peaks by supplying the power needed by the specific application, and gradually ramping the motor up to speed to reduce the current drawn.

In 2003, The Monroe County Water Authority, in Rochester, N.Y., invested in a 4160 V, 750hp Allen-Bradley PowerFlex 7000 medium voltage drive for one of its centrifugal pumps and achieved savings in energy use and peak demand charges of over $23,000 annually.

Kraftwerke Zervreila, a hydroelectric power generation plant in Switzerland, was causing a 20 percent under-voltage condition and line flicker on the electrical grid every time it started its 3.5 MW synchronous water pump motors that drew 1,600 Amps in full-voltage starting conditions. In 2000, Zervreila retrofitted its 40-year-old motors with Allen-Bradley® PowerFlex® 7000 medium voltage drives, which limited their starting current to 200 Amps, greatly reducing its peak energy demand.

Power Factor makes a difference

Power factor, and how it affects displacement and harmonic distortion is another important consideration in drive selection. Drives that are near-unity true power factor translate to reduced energy use.

An example of the effect of power factor on energy cost compares two 4,000 hp drives, one with a true power factor of .95 and one with a true power factor of .98. The annual operating cost for 8,760 hours of use, at $0.07 per KW/hr, results in savings of $63,173 annually using the .98 power factor drive system compared to the .95 power factor drive system.

The Hidden Cost of Transformers

Harmonic distortion, which creates extra heat in the plant power system and losses to the drive system, can also be reduced using a transformerless drive. Transformerless medium voltage drives use an active front-end rectifier (AFE) with a line reactor and integral common-mode voltage protection that has a simple power structure, and reduces drive system size by 30 to 50 percent and system weight by 50 to 70 percent. Since transformerless VFDs produce fewer losses due to less magnetic components in the line reactor, they also eliminate the need for extra air conditioning. A transformer is about 98.5 to 99 percent efficient while an AFE line reactor is about 99.5 percent efficient. This difference of 0.5 to 1 percent can add up to big savings. Engineers can retrofit AFE drives with existing motors, making the drives ideal for process improvement or energy savings projects with existing motors, switches and control rooms, where space is often limited.

An example demonstrates that a 4,000 hp drive using an isolation transformer uses $154,804 in monthly energy. After installing a transformerless line reactor drive at the same power rating, energy cost is only $153,249 per month, for an annual savings of $18,660 using an average rate of 7 cents per kW.

Generate your own energy

Some VFD applications enable users not only to save energy, but to regenerate power, which can be routed back to the system or sold to a utility for additional revenue. La Union, S.A. sugar mill in Guatemala uses its waste energy to produce power for its factory.

In 2002, La Union replaced its steam turbines with more efficient electrical motors and used Allen-Bradley PowerFlex 7000 2300V, 1000hp, medium voltage variable speed AC drives in the boiler fans and pumps. The new drive system now provides 1,420 kW of electrical power with the same 23,000 lbs of steam for additional revenue of $158,480.

One Drive for Multiple Motors

Another way to reduce energy costs is the synchronous bypass method which uses only one VFD to start and synchronize multiple motors by transferring a load from one source to another by matching

the voltage waveform frequency, amplitude and phase relation between the two sources. Using a VFD to start a motor, bring it up to speed and then synchronize it, causes a reduction in full-load current and optimizes the process.

In 2001, Conoco Inc. built a new crude oil pipeline origination/injection station in Montana that pumps a wide range of crude oil types at various flow rates, viscosity and density. It had five different pumping scenarios to consider. Conoco used two centrifugal pumps at 2,500 hp and 1,500 hp to accommodate the differing flows, and one 2,500 hp Allen-Bradley PowerFlex 7000 variable frequency drive with synchronous bypass to control both the motors.

The economic advantages of the VFD with a synchronous bypass are in both installation and operating costs.
A synchronous system for two motors costs 33 percent less in initial capital outlay and reduces drive efficiency losses when compared to multiple drive systems.

Extra Energy-Saving Potential

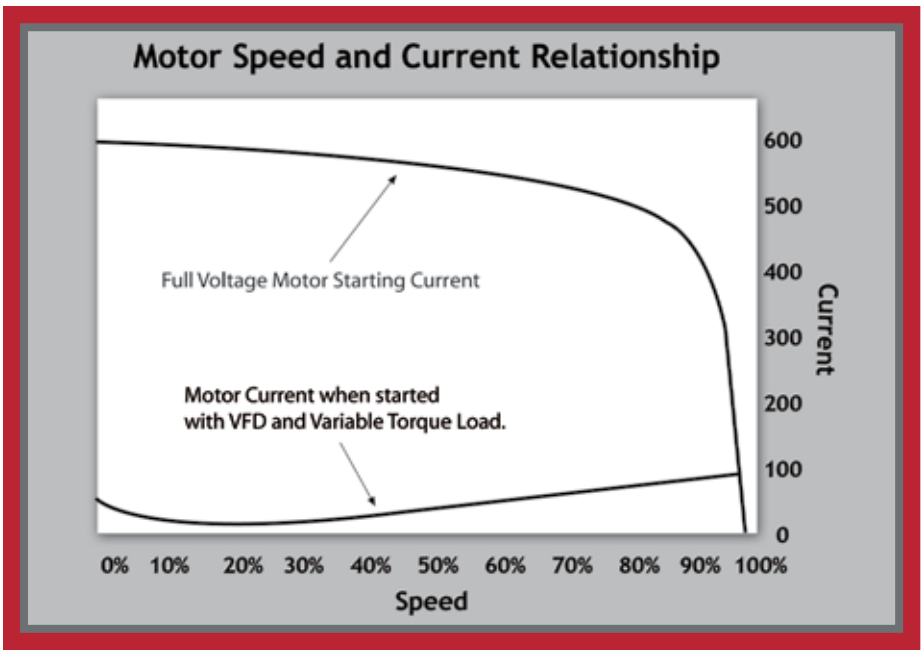
Intelligent motor control solutions including high-efficiency variable frequency drives, are an important part of an energy savings program. But not all drives have the same capabilities. Software features and programmability can further contribute to a drive's energy savings potential by reducing inrush current requirements.

• Programmability - Users can program their VFD to adjust the total acceleration time and current limit and adjust the speed to the load requirement. Current limit on drives is normally set between 105 and 110 percent, whereas using the across-the-line starting method produces current limits of approximately 650 percent.

• SGCTs – Advances in power semiconductor switches like SGCTs (symmetrical gate-commutated thyristors) are designed for high-voltage operation and ensure the lowest switching and conduction losses while maintaining a high switching frequency.

• Power Optimization – Power optimizing features optimize the power usage when operating fans and pumps by adjusting the required voltage to the application. This reduces losses for improved motor and drive efficiency.

• Communication software – Software features enable torque limit and integrated architecture through communication connectivity between the drives, starters and soft starters for greater control and optimization.



Energy management provides return on investment

Careful evaluation of your facility, application, and of the variable frequency drives on the market are the keys to investing well. Look for drives that use intelligent motor control through advanced technology features such as regeneration, synchronous bypass, transformerless options, software and communications to optimize energy consumption. VFDs as energy management solutions are investment strategies for long-term reduced operating costs that have typically provided users payback within one to three years.

For more information on Medium Voltage Drives, visit **http://www.ab.com/mvb/pf7000.html**

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