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THE TRUTH ABOUT ENERGY-EFFICIENT MOTORS

Everyone wants to save energy. It costs less to use less energy. It's the "green" and "cool" thing to do. And if you are in the market for a motor, the government may soon pay you to replace your inefficient motors with new, energy-efficient NEMA Premium® versions.

So, then, you might think that buying a premium-efficient motor is the answer to your energy usage problems. But you would be overlooking an important fact: **an energy-efficient motor is only one piece of the energy savings puzzle.** While premium-efficient motors do help to reduce energy usage, they are by no means the cure-all to every energy consumption problem.

For the highest energy savings, it's important to look at the entire drivetrain when searching for ways to improve efficiency. Consider carefully the misconceptions that surround energy-efficient motors, and be sure you are investing your money wisely to save the most energy possible.

SEW EURODRIVE
www.seweurodrive.com

Common Energy-Efficient Motor Misconceptions

1. Efficiency automatically equals savings.

Efficiency is a property, much like a color, or a material type; a value that doesn't change much. The Department of Energy certifies that a motor meets the "Premium" standard established by NEMA, based on that motor's ability to meet certain efficiency targets. So purchasing a NEMA Premium motor from one manufacturer will very likely give you a motor with basically the same efficiency as a NEMA Premium motor purchased from another manufacturer.

But if you purchase and install just a premium-efficient motor, you are ***not automatically saving all the money you could be saving.*** There are multiple reasons why this might be possible, and we will address some of these in the following paragraphs:

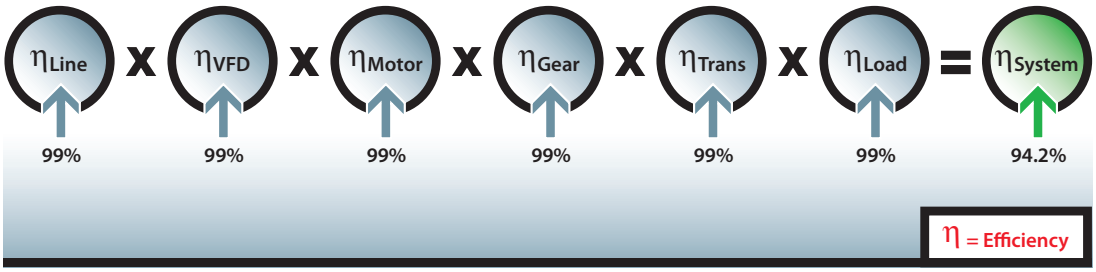
- Your new motor may only be a few percentage points more efficient than your previous motor; in cycling or intermittent duty applications, the savings you recognize are so small, they are outweighed by the higher cost of the new efficient motor.
- Other parts of your drivetrain may be much less efficient, causing higher-than-necessary energy consumption from your efficient motor.
- Your new motor may not be well-suited to saving energy in your type of application, e.g. high-cycling applications.

While premium-efficient motors are important, it's critical to evaluate your entire drivetrain for energy efficiency and remember that energy efficient motors are just a single part of the efficiency equation.

2. Replacing my motor will give me the best bang for my energy buck.

A motor is only one component in the drivetrain (and, truth be told, motors for some time have been comparatively efficient). Each component in a system will inherently have some inefficiency, and these energy losses multiply together to provide an overall system efficiency. Just one component with poor energy usage will quickly drag down the rest of the system. Consider the following theoretical example where every component has an almost-impossible efficiency of 99%:

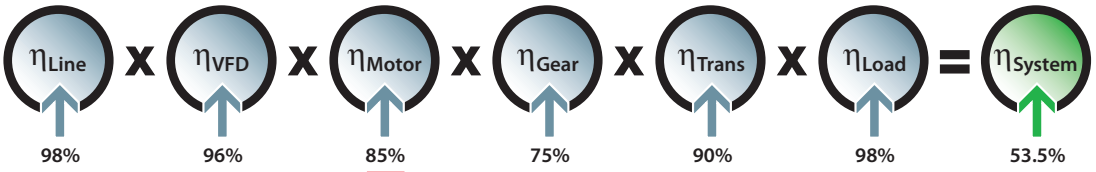
SYSTEM EFFICIENCY: Ideal Scenario...



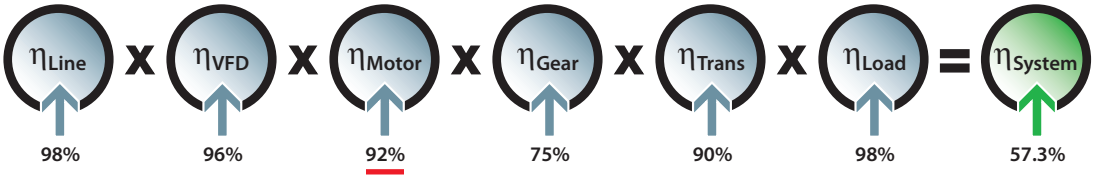
You'll see that even in this example with 6 components of ideal efficiency, you are still losing almost 6% of the energy that you started with.

Now, let's consider two more realistic examples:

10-year-old motor



Brand new, premium-efficient motor



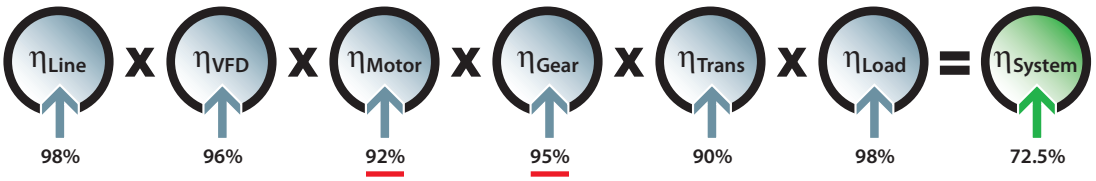
You can see in both examples that you are wasting over 45% of the energy going into the system. You can also see that replacing your motor with a premium-efficient model will save you less than 4 percentage points of efficiency. The other, less efficient components in your drivetrain are still wasting energy, meaning that the investment you've made in a premium-efficient motor will take longer to recoup than you had planned.

3. Replacing my motor will automatically make my line more efficient.

Well, yes – but by less than you might expect. Replacing some of the other components as well as your motor can provide some very substantial efficiency gains, however.

Let's consider, for instance, that we replace the gearbox as well as the motor. Worm gear units, which are installed in most manufacturing environments, are inherently inefficient, as the gears are essentially sliding against one another. There are instances in which worm drives are necessary for the application (e.g. withstanding heavy shock loads, or providing back-driving resistance). But in many applications a helical-bevel gearbox, which operates in a rolling contact manner, will be much more efficient.

Let's take our previous "real world" example and replace both the motor AND the gearbox.



You'll see now we are quickly recognizing substantial, double-digit efficiency gains – nearly 20 percentage points – and your line begins to become much more efficient. If you change your transmission elements from a v-belt to a positive engagement method, or even to a direct-drive method, your efficiency gains can be even higher.

4. A premium-efficient motor is an appropriate energy-saving choice for all motor applications.

Again, it depends. Most premium-efficient motors used in continuously-running applications will begin to show at least modest energy savings (depending, as we have shown, on the other elements in the drivetrain).

But motors used in high-cycling applications may never recognize the efficiency gains that a premium-efficient motor is capable of, partly due to the start-and-stop nature of the application fighting against the higher rotor inertia of many premium efficient motors. Hence, the extra investment in a high-efficiency motor may not ever be completely recouped.

Heat and high-cycling motors

Starting a motor produces a great deal of heat in the windings. This heat is proportional to the current required to start the motor. In many premium-efficient motors, the starting current is much higher than in standard efficiency models. Unless this heat is removed in some way, it will build up and cause motor failure.

Once a motor is started and running, the fan moves air across the motor windings to cool them sufficiently. But, if the motor is stopped before this happens, the heat dissipation process takes much longer. In high-cycling applications, the frequent starts produce a great deal of heat, and the poor air circulation rapidly leads to heat build-up. A motor's ability to manage this heat is what determines the allowable number of starts, or cycles, per hour.

Some NEMA Premium motors, such as the new DRP motor from SEW-EURODRIVE, are engineered to make them more efficient in high-cycling applications. These motors are designed for low rotor inertia, low losses, and less heat accumulation in the windings, increasing efficiency and allowing for a very high number of starts and stops per hour.

Be sure that you consider all the options available to you, and be careful to choose the premium efficient motor that is best suited to your need.

5. Adding a variable frequency drive (VFD) will automatically make my line more efficient.

Actually, a VFD will initially *decrease* your efficiency. As no component can be 100% efficient, the losses introduced by a VFD due to heat, electricity conversion and harmonics are now inserted into the efficiency equation, resulting in a lower total efficiency.

The key to energy savings is smart control. By optimizing acceleration/deceleration ramps, slowing down the motor, and turning it off when not in use, a VFD can optimize a motor's energy consumption. If you drive a motor with a VFD the same way you drive your car to save gas, your energy consumption will drop similarly.

A VFD can also save energy by recycling or sharing regenerative energy. When a motor is trying to stop a high inertia load, it acts as a generator. All of the kinetic energy stored in the machine has to be removed, typically burned as heat with a braking resistor. But many modern regenerative VFD systems can put the energy back onto the grid. Some even allow the energy to be directly given to another VFD just as it needs to accelerate.

The bottom line? Properly used, VFDs can have some big efficiency benefits when added as part of a complete drivetrain efficiency solution.

The Truth About Energy-Efficient Motors

1. They are only part of the efficiency puzzle.

As we have shown, motors are at best one-sixth of the total energy loss potential for an electromechanical drivetrain. And, what's more, they typically aren't even the most inefficient part, either. Mechanical devices, such as external transmission elements, have far more inefficiencies than do electrical devices, so look there first to find your largest energy savings.

2. By revamping your entire drivetrain, you may actually be able to use a smaller motor and save even more.

Right now, you are probably using a motor of a particular horsepower to produce a needed output from your drivetrain. You may be pleasantly surprised to find that, by upgrading your motor, drive, gearbox, and external transmission components, you will have gained enough efficiency that your motor power is now higher than you actually need. You can now save additional energy – and motor replacement costs – by purchasing a lower horsepower motor as a result. For example:

before: 50 output HP needed ÷ 53.5% efficiency = 93.5 HP motor needed

after: 50 output HP needed ÷ 72.5% efficiency = **69 HP motor needed**

3. They are most efficient when integrated with other drivetrain components from the same manufacturer.

Systems where the drive controller, motor and gearbox are all engineered by the same company are by nature designed to work well together, eliminating unnecessary inefficiencies and allowing additional energy savings. For example, integrating an SEW-EURODRIVE DRP motor, helical-bevel reducer, and VFD will provide dramatically higher energy savings than simply replacing the motor.

SEW-EURODRIVE DRP

NEMA Premium motor

- Can handle 1000-2000 cycles per hour
- Only premium-efficient motor with built-in encoder
- Only premium-efficient motor with integral brake, in 3 available sizes
- DRP high performance series, available in 1 – 50HP
- Compact sizing
- Available with NEMA C-flange configuration
- Rated for severe duty environments
- Meets all global efficiency standards
- Part of the SEW modular gearing and drive system

4. They must be well-suited to your application.

Just plunking a premium-efficient motor on the line may not automatically solve all your energy problems, even if all the other components are as efficient as possible. Check to see that the specifications of the motor fit your application, especially if you have high-cycling applications, greater than 10 to 30 cycles per hour. If that's the case, use a premium- or high-efficiency motor designed for such an application with an integral brake, appropriately sized to the motor.

5. Mechanical efficiencies matter, too.

Worm gear reducers, which are attached to a large number of motors, can have an efficiency range of 50 to 88 percent, depending on the number of starts (teeth) on the worm gear.

number of starts	typical efficiency range
1	50-69%
2	70-79%
5	80-88%

As you can see, even the most efficient worm gears have only 88% efficiency, largely due to the sliding nature of the gear contact.

However, helical bevel gear reducers lose only approximately 1.5% of efficiency for each stage of their gearing; as such, a 3-stage helical bevel gearbox would have a 95.5% efficiency rating.

In addition, due to the drastically reduced friction inherent in the rolling contact of a helical bevel gearbox, the usable lifetime of such a system is many times longer than a worm drive system. Although helical bevel gearboxes are higher in initial cost, over the lifetime of the system, in both energy savings and replacement cost savings, they will save you money.

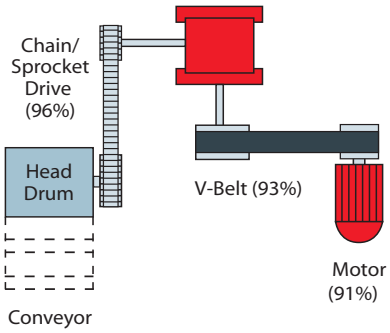
6. Gearmotors eliminate even more efficiency losses.

Gearmotors inherently yield tremendous increases in efficiency. Since a gearmotor has rigid transmission elements, with the motor and reducer rigidly, permanently and precisely coupled and aligned, the motor-to-gear connection has nearly 100% efficiency. By eliminating the friction and slippage associated with V-belts, pulleys and even chains, you can quickly gain a 12-15% increase in efficiency over the average flexible transmission system. (Plus, you'll save even more on the replacement and maintenance of belts.)

Standard vs. Optimized[1]

Standard:

Worm Gear Unit (69%)



Overall drive train efficiency = 56.1%

Power required from utility = 16.2kW

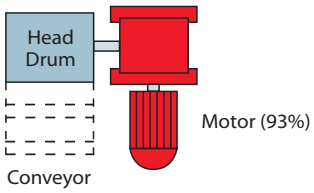
Energy used = 64.8MWh per year

Cost of energy = $6,480 per year

Power loss to inefficiency = 7.1kW

Optimized:

Helical-Bevel Gear Unit (95%)



Overall drive train efficiency = 88.3%

Power required from utility = 10.3kW

Energy used = 41.2MWh per year

Cost of energy = $4,120 per year

Power loss to inefficiency = 1.2kW

Comparison Summary:

- **57% efficiency increase**
- **23.6MWh energy savings/yr.**
- **$2,360 savings/yr.**

[1]**Given conditions:** 20 HP motor operated 16 hrs/day, 250 days/year • Application requires that 9.1kW be delivered to conveyor head drum • Cost of energy = $0.10/kWh • Motor in standard example is high efficiency per EPAct 1997. • Motor in optimized example is premium efficiency per EISA 2007.

Conclusion

As you can see, energy-efficient motors play an important role in reducing energy usage and increasing cost savings. But they are by no means the cure-all to every energy consumption problem. In addition to weighing the characteristics of the energy-efficient motors available on the market, it's important to consider all of the elements in the drivetrain equation.

For maximum energy savings:

- Replace the motor with a NEMA Premium motor, such as the SEW DRP motor.
- Choose a motor appropriate to your particular application.
- Replace worm gear units with helical-bevel gearboxes.
- Use the most efficient drivetrain, such as a gearmotor configuration.
- Eliminate flexible transmission elements.
- Utilize a variable frequency drive (VFD) to intelligently manage your motor's energy usage and recover regenerative energy.
- Consider if your efficiency gains will allow you to use a smaller motor for your desired application.

For more information about SEW-EURODRIVE's new DR motor series of energy-efficient motors, click here or contact Sales for your local SEW representative. For more information about SEW-EURODRIVE and its complete line of energy-saving motors, drive controllers, and gearboxes, visit ***www.seweurodrive.com****.*

THE DRIVE FOR TRUTH
ABOUT ENERGY EFFICIENT MOTORS

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