Revised
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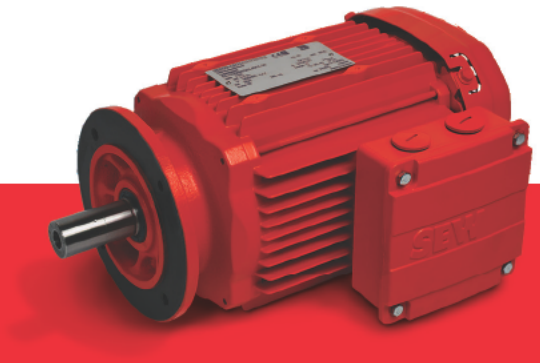
THE TRUTH ABOUT PREMIUM-EFFICIENT MOTORS

THE DRIVE FOR TRUTH
ABOUT ENERGY EFFICIENT MOTORS



Everyone wants to conserve energy. It saves money and is the "green" thing to do. The government wants you to conserve energy. If you are in the market for a motor, they may even pay you to replace your inefficient motor with a new, energy-efficient NEMA Premium® version.

Now, you might think that buying a "premium-efficient" motor is the answer to your energy usage problems. If so, you are overlooking an important fact: **a premium-efficient motor is only one part of the energy savings equation.** While premium-efficient motors certainly do help to reduce energy usage, they are by no means the cure-all.

For maximum energy savings, it is important to look at the entire drivetrain, understand the misconceptions that surround premium-efficient motors and be sure that you are investing your money wisely.

SEW EURODRIVE

Common Premium-Efficient Motor Misconceptions

1. Efficiency automatically equals savings.

Not necessarily; it depends on the application. The Department of Energy certifies that a motor meets the "Premium" standard established by NEMA, based on that motor's ability to meet a certain efficiency level. And, that level is typically based upon 80-100% loading with the motor connected to constant power source (i.e. across the line). 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.

If you only install 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, as discussed below:

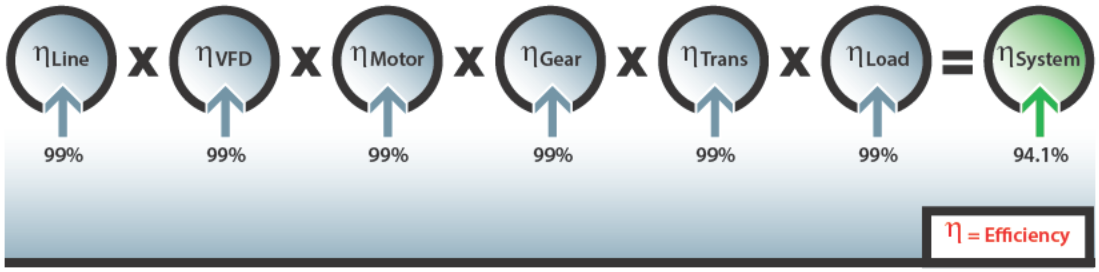
- Your new motor may only be a few percent more efficient than your previous motor. Therefore, in cycling or intermittent duty applications, the savings you recognize are so small that they are outweighed by the higher cost of the new motor.
- Your new motor may not be well-suited to saving energy in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

While a premium-efficient motor is important, it's critical to evaluate your entire drivetrain for efficiency and to realize that the motor is just a single part of the overall equation.

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

It depends. 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 efficiency 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...

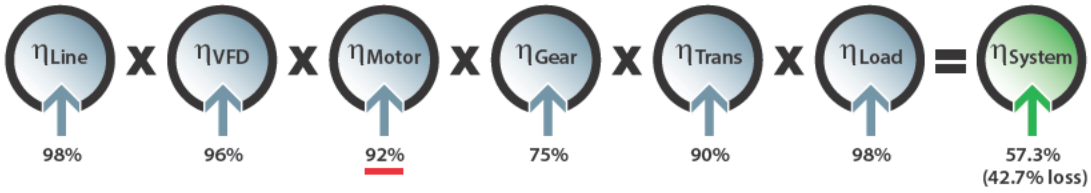


You'll see that even in this example with 6 components of ideal efficiency, you are still losing almost 6% of the energy.

Now, consider two more realistic examples:

10-year-old motor

New, premium-efficient motor



Motor Savings: 92-85 = **7%**
System Savings: 57.3-52.9 = **4.4%**

You can see in both examples that you are losing over 42% of the energy going into the system. You can also see that replacing your motor with a premium-efficient model will save you just over 4% efficiency, even though the new motor is 7% more efficient than the old motor. That is because the other, less efficient components in your drivetrain are still wasting energy. Therefore, the investment you have 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. However, replacing some of the other components along with your motor can provide some very substantial efficiency gains.

Consider, for instance, that you replace the gear unit 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 causing heat (energy loss).

Sure, 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 gear unit, which operates with rolling contact, will be much more efficient.

Take the previous "real world" example and replace both the motor AND the gear unit.

Now, you are quickly recognizing substantial, double-digit efficiency gains – nearly 20% – and your line begins to become much more efficient.

To gain even more efficiency, consider changing or eliminating your transmission elements. Replace a v-belt with a direct drive or use a shaft-mounted gear unit. Shaft-mounted units, such as the TorqLOC® from SEW-Eurodrive, offers a keyless, taper hollow shaft with a shrink disc that has a liberal tolerance so it installs easily. It can even retrofit onto an existing keyed shaft.

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

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

But motors used in high-cycling applications may never recognize the entire efficiency gain of a premium-efficient motor, 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.

However, 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 with low rotor inertia, low losses, and less heat accumulation in the windings, which increases efficiency and provides 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.

Maybe. As the efficiency equation shows, a VFD is a load. It produces heat (losses) from electricity conversion, switching frequency, and harmonics. So by itself, it will **decrease** your system efficiency. What's more, many VFD's have an adjustable carrier frequency that reduces audible noise during operation. Unfortunately, when the carrier frequency increases, so does the heat. In fact, the heat produced at a high carrier frequency can be so significant that a room full of VFD's may require a substantial increase in air conditioning.

Thus, the key to energy savings is to use a VFD to reduce other losses in the system (i.e. smart control), as in the following applications.

- **Regenerative Energy:** When a motor is trying to stop a high inertia load or lower a load, it acts as a generator. All of the kinetic or potential energy stored in the machine has to be removed. Typically, it is wasted as heat through a braking resistor. But a regenerative VFD can put the energy back onto the grid. Some even allow the energy to be directly given to another VFD as it accelerates, such as in a storage retrieval system.
- **HVAC**: Typical systems used in HVAC contain mechanical dampers with motors that run continuously. Using a VFD to turn off the motor or to reduce the motor speed is much more efficient, especially since the load decreases more than four times at half the speed!
- **Soft Start:** Using a VFD to control the acceleration on a cycling application lowers the motor starting current. So, the motor runs cooler since less energy is converted to heat.
- **Motor Efficiency Correction:** Motor nameplate efficiency is usually rated at 80% loading. Therefore, when a large motor is applied to a small load (e.g. 1 HP used instead of 0.25 HP), its actual efficiency decreases considerably. Using a VFD with vector control (or VFC technology) optimizes the motor efficiency, regardless of the loading conditions.

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

The Truth About Premium-Efficient Motors

1. The motor is only part of the efficiency equation.

As you have seen, a motor is at best one-sixth of the total energy loss potential for an electro-mechanical drivetrain. And, what's more, it typically isn't even the most inefficient part. 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 certain output from your drivetrain. You may be pleasantly surprised to find that, by upgrading your gearbox, drive, and external transmission components, you will have gained enough efficiency that your motor power is now higher than you actually need. Therefore, you may be able to save additional costs by purchasing a lower horsepower motor. For example:

before: 50 HP load ÷ 53.5% efficiency = 93.5 HP (use 100 HP)

after: 50 HP load ÷ 72.5% efficiency = **69 HP (use 75 HP)**

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

Systems where the VFD, 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 gear unit, and VFD will provide dramatically higher energy savings than simply replacing the motor.

SEW-EURODRIVE DRP

NEMA Premium motor

- High performance 1 – 50HP
- Handles 1000-2000 cycles/hour
- Optional built-in encoder
- Integral brake available in 3 sizes
- Compact integral gearmotor
- Available with NEMA C-flange
- Rated for severe duty environments
- Meets all global efficiency standards

4. The motor must be well-suited to your application.

Just placing 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. Ensure that the specifications of the motor fit your application, especially if you have a high-cycling application that is greater than 10 to 30 cycles/hour. If so, use a premium efficient motor designed for such an application with an appropriately sized integral brake.

Also, where possible, use the smallest motor for the application so that it is loaded near 80% and operates as close to it nameplate efficiency as possible.

5. Mechanical efficiencies matter, too.

Worm gear units, which are very common in the industry, have an efficiency range of 50 to 88 percent, depending on the number of starts (teeth) on the worm gear, as shown below.

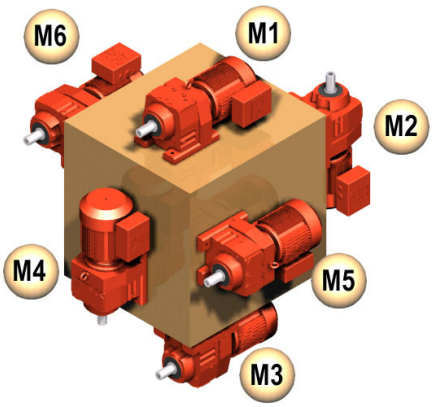
number of starts	typical efficiency range
1	50-69%
2	70-79%
5	80-88%

Their poor efficiency is due to sliding gear contact. Since sliding produces friction, much of the energy is wasted through heat. Conversely, helical bevel gear units use rolling friction, so they lose only 1.5% of efficiency for each stage. Thus, a three-stage helical bevel gearbox is 95.5% efficient.

Although helical-bevel gear units are higher in initial cost, they will save money in energy over the lifetime of the system. If you are an end-user, consider specifying helical-bevel gear units the next time you purchase equipment for your plant. It is in your best interest.

6. Gearmotors eliminate even more efficiency losses.

Gearmotors inherently yield tremendous increases in efficiency compared to the average flexible transmission system. Since a gearmotor contains a motor that is rigidly coupled and precisely aligned with the gear unit, the connection is nearly 100% efficient. By eliminating the friction and slippage associated with v-belts, pulleys or chains, you can quickly yield a 12-15% increase in efficiency. You will save even more on the replacement and maintenance of belts. And, don't forget about safety...



7. Oil may be costing you.

Oil plays a role in energy savings because it creates heat as it churns inside a gear unit. And, the amount of heat increases as the oil volume increases. Not only does heat increase your energy bill, it also damages gears and seals. Excessive heat is especially problematic for larger gear units - typically with an output shaft diameter greater than 2.25".

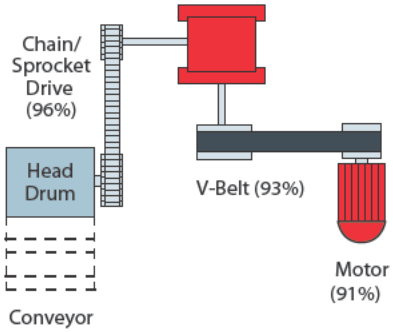
Consider the following when designing or servicing your gear units:

- **Mounting Position:** The orientation of the gear unit determines the amount of oil. M1 contains the least; M2 and M4 contain the most. Whenever possible, design your system for M1.

Standard vs. Optimized[1]

Standard:

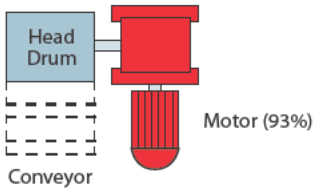
Worm Gear Unit (69%)



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 from 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 from 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.

- **Input Speed:** The faster the oil churns, the higher the churning losses. Therefore, a gear unit with a 4-pole motor (1800 rpm) will run cooler than with a 2-pole motor (3600 rpm).
- **Synthetic Oil:** Synthetic oil is known to reduce friction by 25%, which can be significant on worm gear units or large gear units. Synthetic oil allows the gear unit to run cooler, doubling the oil service life, which reduces your maintenance interval and costs.
- **Viscosity:** The "thicker" the oil, the more resistance it has to flow and the more energy it requires to move. Always use the correct viscosity, considering the type of application and ambient temperature.

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 motor with a NEMA Premium motor, such as the SEW-Eurodrive DRP.
- 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.
- Use a VFD to optimize your motor efficiency, control its energy usage, or recover regenerative energy - providing your application merits its use.
- Consider if your efficiency gains will allow you to use a smaller motor for your desired application.

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

You can now create your own custom gearmotor quotation, including all options and CAD drawing fast and easy with SEW-Eurodrive's exclusive PT Pilot program. Visit ***www.ptpilot.com****.*

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